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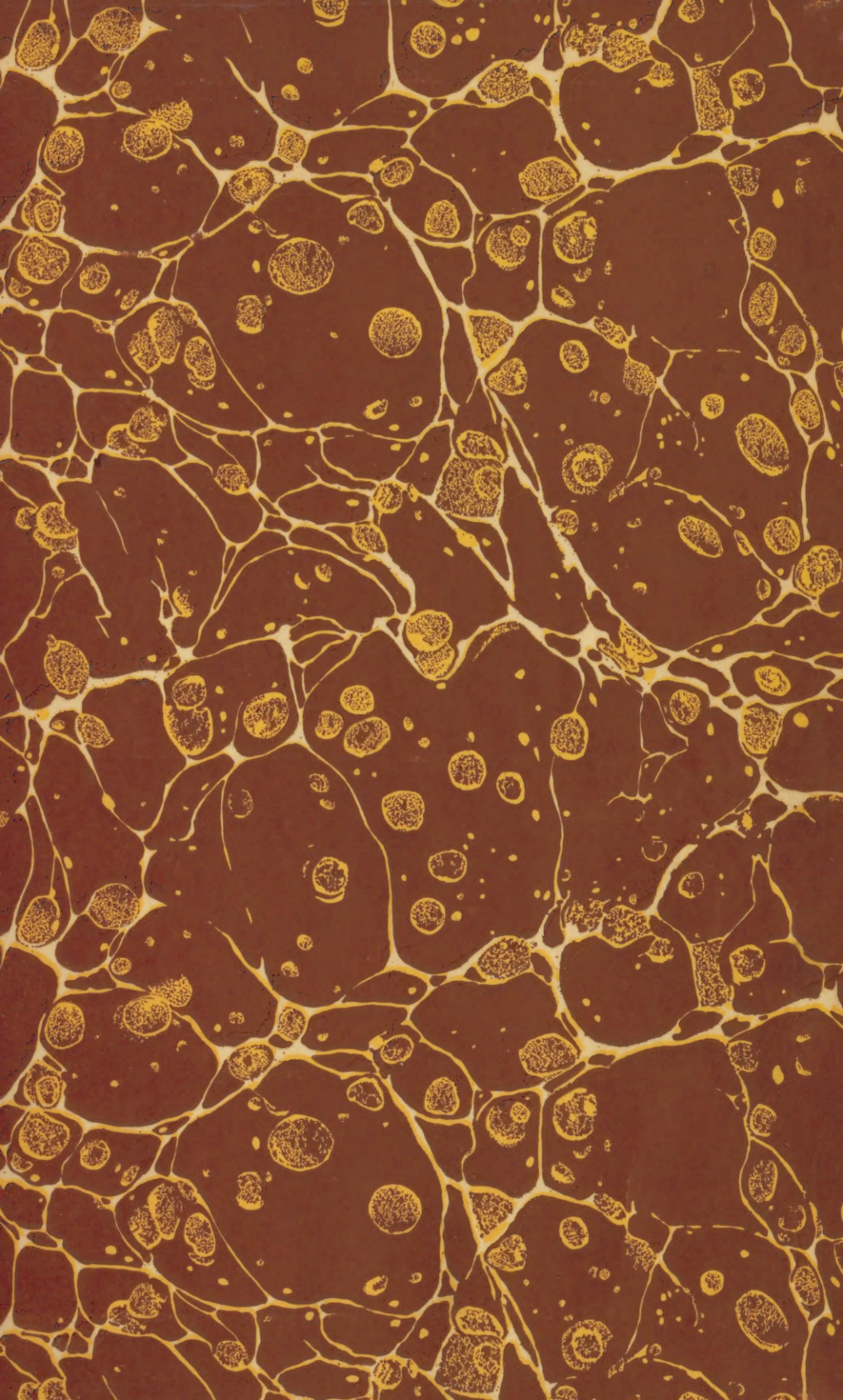
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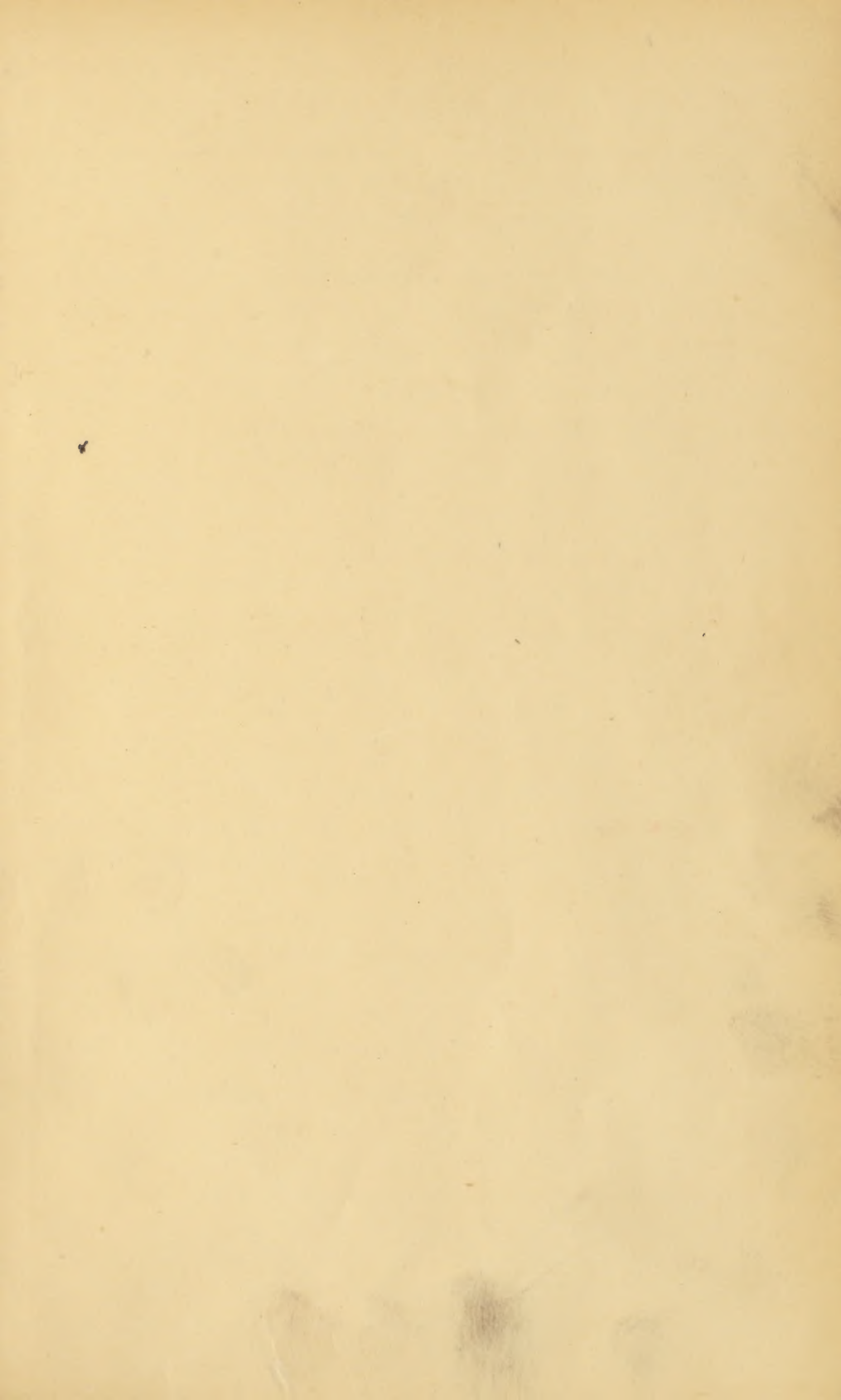
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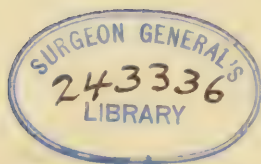
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RADIUM

Abstracts of Selected Articles on Radium and Radium Therapy



COMPILED BY
AMERICAN INSTITUTE OF MEDICINE
for
UNITED STATES RADIUM CORPORATION
(1)
NEW YORK

[New York 1925]

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FOREWORD

In presenting to the medical profession this book of abstracts from articles on the medical use of Radium, prepared for us by the American Institute of Medicine, we feel that we are repaying in part for the innumerable courtesies and kind assistance given us by so many physicians all over the world. The work is a complete one and will, we trust, be of service to users of radium who seek a ready reference to the world's writings on this very important phase of therapeutics.

UNITED STATES RADIUM CORPORATION.

THERAPEUTIC HISTORY AND PROGRESS OF RADIUM

Like many another revolutionary discovery, the possibility of employing radium as a therapeutic agent was first suggested by an accident. Had Henri Becquerel been less scornful of his assistant, Matout, when he remarked that his superior might find a safer repository for a tube of pure radium than the pocket of his waistcoat, Becquerel would have been spared the discomfort of the burn upon the skin directly beneath that same waistcoat pocket, which about two weeks thereafter gave Matout a chance to employ the Gallic equivalent of "I told you so." But medical science might have waited much longer for this invaluable adjunct to its armamentarium.

It was the "Becquerel burn" which gave Pierre Curie the idea that radium might prove useful in medical work, but it was at Besnier's suggestion that he offered some of the precious element to Dr. Danlos of the St. Louis Hospital. This was in 1901. Since then, the therapeutic use of radium has advanced with the strides of a giant, so that looking over the early number of *Le Radium*, the magazine which was founded by the French workers in the first flush of their enthusiasm, seems almost like reading ancient history.¹

Yet it was not until 1906 that radium therapy can actually be said to have become a reality, for it was only then that Henri Dominici, a profound student of the morbid reactions of connective tissue, set forth the principle of ultra-penetrating radiation, resolutely turning his face away from the then-prevailing opinion that filtration inevitably removed the essential properties from radium. Dominici, "whose attention was awakened by the process of evolution without necrosis which histology showed us to take place in the deeper tissues exposed to radiation, noticed the homogeneity of the radiation after it had undergone filtration by four millimeters of such a dense metal as lead. Eliminating secondary radiation by another filter of very slightly dense matter he noted that the rays thus selected presented remarkable properties, characterized by a relatively marked innocuousness for healthy tissues, whereas, on the other hand, they preserved all their special action on neoplastic tissues."²

So it is to Dominici, next to the Curies themselves, that the world owes its knowledge of the unequalled curative properties of radium. Not only did he in the beginning make its employment practical and effective, but he extended the scope of his experiments and researches through six laborious years, so that practically all that was accomplished in the field of radium therapy during that entire period was but a carrying forward of what Dominici had initiated.

The abstracts here collected represent the contributions to medical literature concerning the use of the radium element in the great struggle

References:

¹ Bécélère, A.: Sur l'emploi thérapeutique des sels de radium. *Le Radium*; 2: 49, 1905.

Abbe, Robt.: Action du radium sur quelques tumeurs particulières, *ibid.*, p. 55.

² Barcat, J.: Henri Dominici and his work. *Arch. Radiol. and Electrother.* 24: 343, 1919-1920.

against disease. They have been culled from many sources, and having broken through the barriers which unfamiliar language, geographical remoteness, or even mere obscurity of publication heretofore imposed upon them, are now arranged so as to be easily accessible to every medical man who cares to read in them a record of study, of labor and of achievement, without parallel in the history of science.

No matter in what particular branch of the work he may be interested he will find here the reports of those who have actually labored along this line. History alone can give *perspective*, but it is only by traveling along a road that we can reach a point where we are able to pause, look back, and note the landmarks in their true relations. These articles—records inscribed sometimes in the bright sunshine of a brilliant success, but very, very often in the dark shadow of a bitter failure—are the landmarks along the pathway of the progress of radium therapy. The records of successful achievement have much to tell us, but there is also much to be learned from those who failed, and still more from those who “darkness” was later “turned into day.” It is well for those who enjoy all the benefits of a highly developed civilization to give a thought now and then to the endurance of the pioneers who made that civilization possible, and it is well for those in whose hands radium is now performing such wonders to be fully familiar with the work of those who preceded them, even in the youngest of all the sciences.

The possibilities of radium therapy seem almost infinite, and there is every reason to believe it is still in its infancy. But the record of what has up to this time been accomplished, gathered together as it appears here, is already an impressive array of testimony to the possibility of human progress into realms hitherto unknown.

SECTION I.
RADIUM—ITS PHYSICS, BIOLOGY AND GENERAL
THERAPEUTICS

SECTION I.

RADIUM—ITS PHYSICS, BIOLOGY AND GENERAL THERAPEUTICS

Recent Developments in Radium Therapy.

R. Duncan, Calif. St. J. M., 19: 102, 1921.

Radium is an element which owes its therapeutic properties to certain rays emitted during the process of its disintegration. These rays are termed alpha, beta and gamma rays. The first products of its disintegration are helium, an inert gas, and radium emanation to which it owes its radio-activity. It is to the changes produced by these rays in the tissues that radium owes its therapeutic value. By means of an apparatus perfected by Prof. Duane of Harvard University, it is possible to collect from a sufficient quantity of radium in solution the emanation which may be used for therapeutic purposes, and which has all the properties of the parent substance.

Radium emanation, a gas, is capable of great concentration. This permits of having in a very small container several hundred times the activity that might be obtained from a similar bulk of the radium salts. This is of tremendous advantage where radium is to be applied within cavities or where screened or unscreened tubes are to be buried with the tumor substance.

When a small amount of sodium chloride or a piece of lead foil is encased in a glass tube properly connected with this apparatus, and the emanation is brought and retained in contact with it for three hours, the active deposits radium B and C, which emit beta and gamma rays, will be deposited thereon, rendering the substance temporarily radio-active. The salt may be dissolved in a proper quantity of water to produce a physiological salt solution, its radio-activity measured and administered intravenously. Lead foil, when rendered radio-active in this manner, may be cut into the desired shape for the treatment of various superficial lesions.

To successfully employ radium emanation an adequate quantity of radium is essential, one gram being approximately the minimum amount that is practical. From each gram of radium in solution there can be collected each twenty-four hours 166 millicuries, minus a small loss. While the emanation collected undergoes rapid disintegration, losing one-half every four days, and practically all in about twenty days, more is being constantly given off, so that the number of millicuries available at the end of thirty days is equivalent to the number of milligrams of radium element in solution. The author makes it a rule, unless a special applicator is required, to collect the emanation in small glass capillary tubes, approximately $\frac{3}{4}$ centimeter in length and 1 millimeter in diameter. These tubes are accurately measured to determine their radio-activity. By encasing these tubes in various metal capsules, applicators or screens, the character of the beta and gamma rays may be modified as desired.

Histologically it has been shown that, though all tissues are influenced by a sufficient quantity of radium radiation, normal and pathological tissues vary in their susceptibility, imperfectly formed cells and tissues being less resistant than normal tissues. Janeway and Ewing

have determined that carcinomatous cells are destroyed by one-fourth the dose necessary to destroy a normal epithelial cell.

Beta rays with proper dosage, affect an area of about $1\frac{1}{2}$ centimeters; gamma rays, in sufficient quantity, and with proper screening and technic, may be effective for a distance of several inches. The beta rays are used chiefly in superficial lesions of the skin and mucous membrane. Where it is desirable to radiate deeper tissues, the beta rays may, with one millimeter of platinum or other proper screening, be absorbed, leaving available the more penetrating gamma rays.

The efficiency of radium therapy depends upon the proper radiation of pathologic tissue. By means of a suitable instrument, the bare or unscreened glass tubes containing the radium emanation may be imbedded in a tumor, where they are allowed to remain. These tubes gradually lose their activity, remaining active for about 20 days. In certain cases where it is desirable to maintain a continuous radiation for a considerable period of time, a number of these tubes with quantities varying from 5 to 10 millicuries may be imbedded at a distance of about $1\frac{1}{2}$ centimeters. The dosage thus obtained may be computed by multiplying the original amount buried by 132, which gives the total number of millicurie hours dosage.

The author then mentions some of the conditions in which radium raying has been of benefit, among them being: certain diseases of the bladder, larynx, pharyngeal spaces, antrum, esophagus, superficial lesions, benign and malignant uterine bleeding, menopause, uterine fibroids, uterine cancer, cervical carcinoma, Hodgkin's disease and leukemia. He lauds the post-operative prophylactic use of radium, especially after breast amputation.

On the Local and Generalized Action of Radium and X-Rays upon Tumor Growth.

S. Russ, Helen Chambers and Gladys M. Scott, Arch. Radiol. & Electrother., 26: 129, London, Sept., 1921.

In the treatment of tumors by radiation the action on the animal body as well as on the tumor cells must be considered. The effect on the latter varies with the amount of radiation; a large dose causes the death of actively growing malignant cells; a somewhat smaller dose shows, while a very small dose apparently stimulates the growth rate of the cells. Differences are also observed in the effects on the animal body. Prolonged exposure of the animal to the rays causes wasting and death; shorter exposures diminish the rate of increase of body weight without apparently affecting the general health; and very small doses result in the development of a state of increased resistance to an implanted tumor. Experiments are here reported dealing with: (1) the effect of rays in varying doses on inoculation; (2) the effect of rays in various doses on the body growth of normal animals and the subsequent susceptibility to inoculation of malignant cells; and (3) the effect of rays in various doses on animals with tumors. Most of the work was done with a Jensen rat sarcoma, although in addition another slow-growing rat sarcoma and a rat carcinoma were employed. To test the effect of the rays on the malignant cells, fragments of a tumor removed from the

animal body were exposed for periods varying from forty minutes to two seconds, and then implanted in normal rats; the rate of growth was observed. The source of radiation was a capsule containing 20 mg. radium bromid spread over an area of 4 sq. cm. and covered with a thin layer of varnish to absorb the alpha rays and soft beta-rays. The lethal dose was found to be about 35 for the Jensen tumor and the carcinoma, and somewhat longer for the sarcoma. With diminished doses, first a reduction was observed, and then a slight quickening of the rate of growth as compared with that of an untreated tumor. The susceptibility of the animal receiving the implant is also a factor to be considered.

To test the effect of irradiation on the body weight, normal animals were exposed to rays from a Coolidge tube, spark-gap 4.5 cm. between 5 cm. spheres, at a distance of 20 cm. with no screening except a thin mica sheet below the tube, and a perforated cardboard over the box, different batches of animals being exposed daily for one minute, twelve seconds or two seconds, over periods of weeks. The longer exposures cause a diminution in the rate of growth, but with a diminished dose the increase was more rapid than in normal animals. In rats exposed for twelve seconds daily over varying periods of time before implantation of tumor cells, the tumors grew at a slower average rate than in the normal animal, although an absolute degree of immunity could not be conferred. The longest exposures did not produce the highest degree of immunity. Other authors have observed that, after very large doses of x-rays, an immune animal becomes temporarily susceptible to tumor inoculations, and the present authors have previously shown that a single large dose of x-rays increases the susceptibility.

To test the effects of irradiation on animals with tumors, three methods were used: (1) Four days after inoculation the radium capsule was held against the graft; it was found that the exposure necessary to prevent growth was practically the same as that required when the tumor was irradiated outside the body. In another series double inoculations were made, and four days later the tumors on the right sides of the animals were irradiated for periods of from ten minutes to twelve seconds, and the doses repeated at intervals of a week. Weekly exposures of from ten to five minutes checked and those of one minute or less increased tumor growths. Exposures amounting to one-fiftieth of the lethal dose appeared to have an accelerating effect. (2) Twenty-four animals were inoculated with tumor cells, and on the following day one-half were exposed to the rays for twelve seconds, the graft itself being screened with lead 2 mm. thick. Exposures were made daily for a month, and the tumors of both irradiated and control animals were measured twice a week. A decreased susceptibility to tumor growth followed generalized irradiation. After having been shown that, while repeated exposures to small doses increase the resistance of the animal, the effect on the tumor cells is to accelerate the rate of growth, experiments were made to determine which process outweighed the other. (3) Two lots of animals were inoculated, and one lot was exposed for from five minutes to two seconds daily for various periods of time. Longer exposures retarded tumor growth, but in nearly every case the death of the animal followed the five-minute exposures, while the one-minute exposures diminished the rate of increase of body weight. With a further reduction in exposure the body weight increased more than

normally; but there appeared to be slight stimulation of the tumor cells.

The bearing of these investigations on radiologic treatment of tumors in man is twofold: (1) With either radium or x-rays the uniform irradiation of large tumors is hardly possible, and, while small variations from the lethal dose are unimportant, if the radiation reaching the edge of the tumor is so diminished as to form only a small dose the effect on the cells may be stimulating rather than destructive. (2) While large generalized doses lower the resistance to tumor growth, very small generalized doses have the reverse effect. It is, therefore, suggested that the local intensive irradiation of a tumor should be supplemented by feeble generalized irradiation of the patient, the tumor cells not being exposed to the latter.

Radium and Research. A Protest.

C. Everett Field, Med. Rec., 100:764, Oct. 29, 1921.

The writer openly criticizes the deliberate policy of belittling radium therapy which has been the common custom of the Director of the Crocker Cancer Research. He states that since 1913 he has made over 7,000 intravenous injections of radium element, in dosages ranging from 10 to 100 micrograms, and has invariably, with one exception, witnessed a remarkable increase in the red-cell count, in spite of the fact that Dr. Wood of the Crocker Cancer Research is reported to have affirmed that "radium does not increase red blood-corpuscles nor prevent hardening of the arteries. It does not have a stimulating effect on the appetite—if anything it kills the red blood-cells." Furthermore, radium markedly increases appetite and all digestive functions. In early cardiovascular degenerations it has been favorably reported for twelve years. Probably threescore careful radium therapists here and abroad will bear witness to these facts. As for the statement that radium would cure 1 case in 1,000 of cancer (made by Dr. F. C. Wood), one might justly query why even the one cure occurred. The writer confesses that he is entirely in the dark as to the purpose of any policy which permits such statements to emanate from a research institution. The writer then enumerates a large number of institutions devoted to radium therapy and questions whether anyone would have the heart to hold out to the cancer victim a hollow mockery to the effect that radium would "perhaps cure 1 case in 1,000." He repeats a favorite personal quotation: "Radium is the most remarkable therapeutic agent emanating from the laboratory of the Almighty."

Dosage in Radium Therapy.

Gioacchino Failla, Am. J. Roentgenol., 8: 674, Nov., 1921.

Failla suggests that radiation doses be estimated according to the amount of energy absorbed by the irradiated tissue; this includes not only the pathologic tissue, but also the normal tissue surrounding it, which must not be injured unduly. The success of the treatment depends upon the relative amounts of radiant energy absorbed by healthy and by diseased tissue, as well as upon the absolute amount of radiant energy absorbed by the pathologic tissue. The intensity of a treatment,

which may be measured by the duration of the exposure or by the strength of the radio-active source, is not without influence on the final result and must be taken into account. The physical constants which enter into the complete specification of a dose are: (1) The strength of the radio-active source; (2) its distribution; (3) the total filtration used; (4) the duration of the irradiation; and (5) the relative positions and distances of the source of radiation, the pathologic tissue, and the normal tissue. On the basis of the above data the dose can be expressed in any unit selected, but since the biological effect must be due to the radiant energy absorbed by tissue, it is suggested that this be taken as measure of the dose administered, and that it be expressed in calories. At the present time it is not possible to express doses in calories for all forms of radium treatment, inasmuch as some of the data necessary for such calculations are unavailable. The same data are needed for proper interpretation of clinical results, and, therefore, it is important that experiments leading to the solution of this problem be carried on.

Examples are given to illustrate the advantages of the method of dosage suggested. Doses of gamma radiation given with various applicators at different distances from the skin, which produce the same degree of erythema, are the same when expressed in calories but very different when expressed in milligram-hours. The latter notation can be used to represent only the amount of radium energy emitted by the radio-active source, but not that part of the emitted energy utilized during the treatment, which is really the dose. Once a system of dosage based upon the effective radiation of tissue at any depth is established the knowledge obtained from the treatment of patients can be used to better advantage, and the difficult problem of determining the necessary and sufficient doses for different pathologic conditions will be greatly simplified. It should be noted, however, that even though the amount of radiation necessary to destroy a certain tumor is known and administered, it does not follow that the patient will recover. If a mistake is made in estimating the extent of a lesion, this will result in the giving of an insufficient dose, and, therefore, a full knowledge of cancer is essential for the successful application of radium. The method of dosage for radium therapy suggested in this paper can be used for roentgenotherapy as well.

Radium's Place in Therapy.

A. Strauss, Ohio State M. J., 17: 315, May, 1921.

Radium therapy is coming into such general use that it is high time the general practitioner became acquainted with these newer methods of controlling and curing many malignant growths. Radium is used in the form of insoluble sulphate except by those who possess more than a gram, when emanations are employed. The various modes of use are described, and the efficacy of the three types of rays. The alpha have no therapeutic value, the beta are used for superficial lesions and the gamma are the shortest and most penetrating. Cells differ in their susceptibility to radium from most to least sensitive, in the following order: lymphosarcoma, basal cell carcinoma, cubic cell carcinoma, sarcoma of the uterus and skin. The more scirrhus a cancer, the more resistant it is. The changes undergone by tissue exposed to radium are

detailed, and the affections amenable to it discussed at length. These are Group (1) those in which radium is the method of choice: lymphosarcoma, Hodgkin's disease, sarcoma of the extremities, fibromyomata of the uterus uncomplicated and not enlarged above the umbilicus, menorrhagias, carcinoma of the cervix uteri, carcinoma of the face, obstructing thymus in infants, keloids, epulis, nevus (hemangioma), and vernal catarrh. Dr. Strauss emphasizes the fact that radium should not be "properly reserved for inoperable cases" but should be used in preference to operations wherever possible. Group (2) comprises diseases in which radium is to be used in conjunction with surgery: carcinoma of the fundus of the uterus and of the breast, of the prostate, of the bladder, of the rectum, orbital tumors, glioma of the brain, carcinoma of the jaw, of the tongue, of the lip, and of the antrum. Group (3) are affections in which radium has given relief, but in which more experience is necessary before its use can be advocated above other methods: leukemia, corneal ulcers, toxic goiters, tumors of the tonsils, tuberculous adenitis, carcinoma of the larynx, and of the esophagus, and leukoplakia. In Group (4) radium is only palliative, as in advanced inoperable carcinoma. Group (5) consists of skin diseases which may be treated as effectively by other means. Dr. Strauss describes the results which he obtained in the groups mentioned, and makes conservative suggestions regarding treatment. He cautions us to remember that "inoperable" is no longer synonymous with "incurable."

The Absorption of Radium Radiations by Tissues.

Gioacchino Failla, Am. J. Roentgenol., 8: 215, May, 1921.

After a description of the apparatus used, consisting of a gold leaf electroscope and conical ionization chamber, and after a detailed account of the experimental procedure, including a list of limitations to which it is subject, absorption curves are given for aluminum, brass and lead. These show that (a) as the filter increases in density the transition from soft to hard radiation is quite sharp; that (b) beyond a thickness of filter of a few millimeters in the case of aluminum and brass the absorption is exponential, but not in the case of lead in the range of thickness used; and this shows that (c) filtration by a small thickness of metal is sufficient to give a radiation absorbable exponentially by metals of medium or low atomic weight, the radiation, however, not being homogeneous, as indicated by the lead absorption curve.

The exponential absorption serving as a criterion for the quality of radiation in deep therapy, it is plain that a metal should be used as the primary filter, and that a secondary filter, composed of light elements like tissue, should also be used to remove the soft secondary radiation of the metal. Beyond a certain point, additional filtration, while slightly increasing the penetrating power of the radiation, decreases its intensity considerably. The limiting factor in deep therapy is the effect on the skin. The fraction of skin radiation which reaches a given depth can be varied to some extent by varying the filtration or the distance of the applicator from the skin. Examples worked out by mathematical formulae and tables based upon the projection of radiation curves in combination with these formulae indicate how adjustments are to be

suited to individual cases. The coefficient of absorption depends upon the quality of the radiation and the nature of the absorber. The same radiation is absorbed to a different extent by different tissues. For soft tissues the coefficient is proportional to the density of the tissue. The absorption by tissue from different organs, excepting lung tissue, fat, and solid bone, is nearly the same. One may take 0.075 as the coefficient of absorption of gamma radiation filtered through 1.92 millimeters of brass, and calculation from this gives 10 cm. as approximately half of the thickness value of human muscle tissue for gamma rays. In practice solid bone forms only a small fraction of the total thickness traversed by radiation and may be regarded as of no great consequence.

The results given in this paper may be used for the solution of problems in radium therapy, noting that the radiation reaching any given depth of tissue is always the minimum amount which will reach this depth under the conditions of application, and that skin doses of beta and gamma radiation are not to be compared according to the ionization values given, but must be determined independently by physiological experiments.

Radium and the General Practitioner.

Julius J. Heimark, Journal-Lancet, 41:284, May 15, 1921.

The progress which radium has made as a therapeutic agent is to no one more important than to the general practitioner though a comprehensive knowledge of its usefulness is scarcely possible to anyone who cannot give a great deal of time to its study. Much discrepancy is found in the statistics. This the author attributes to the failure to present comparisons on a similar basis, as well as to the fact that statistics are compiled by inexperienced operators.

From the radiologist's standpoint, he had to blaze his own trail. Dosage, for example, was a matter of experimentation. Screening was a problem, attended by errors resulting in severe inflammatory reaction, producing fistulae or extensive sloughs. The value of cross-fire was not appreciated early enough. Metastasis and adjacent glands were often inadequately treated or neglected. But in spite of numerous difficulties, radium has proven extremely successful and its zenith is not yet reached. It is a valuable adjunct in the treatment of malignant conditions and is too seldom used, the work done in cancer cases being the most important phase of its application. In non-malignant pathology radium therapy has but recently come into its own. Menorrhagia is mentioned as among the most greatly benefited conditions, usually yielding to one treatment by radium. If the proper dosage is applied it does not produce cessation of menstruation. Metrorrhagia is ideally treated by radium therapy. Contraindications for its use in menorrhagia are histories of pelvic infection and symptoms suggestive of malignancy in which cases abdominal hysterectomy should precede radiation. In angiomas, radium is recommended as the choice treatment. Unusual possibilities have been demonstrated in the radium treatment of hyperthyroidism. In thymus gland enlargement radium has certain advantages over x-ray treatment, being more rapid and resulting usually in a cure after one treatment. Tuberculous adenitis often responds to radium therapy, and when it does not, other forms of treatment are not rendered less effective by being

preceded by radium. In a small series of incipient cataracts treated with radium, 87.5 per cent. showed improvement in clarification. Small doses of radium over the spleen in myelogenous leukemia usually result in decrease of the number of these cells and decrease in size of spleen, though there are no reports of recovery from this disease under any form of treatment. Dermatologists find radium indispensable. Actinomycosis has been successfully treated by radium. Chronic leukorrhea is among the conditions too recently subjected to treatment for conclusions to be available. If a death-rate exists at all in connection with radiotherapy, it is extremely low.

A Report on the Clinical Use of Radium.

W. S. Newcomet, Therapeutic Gazette, 45: 313, May 15, 1921.

During the last year the Radium Department of Jefferson College Hospital, Philadelphia, Pa., has treated 193 new cases and continued 48 from previous years. Applications varied in length from one-half hour to seventy-two hours. The cases were not selected, but were treated just as they came to the department, many of them having advanced to a moribund state. They were given the chance of whatever comfort might be gained, even if only for a few hours before a fatal termination of the disease.

In one case of sarcoma of the pelvis, the patient, who had been under influence of narcotics for months, lapsed into coma for several days after application of radium, but gradually recovered, becoming rational, and since then has experienced little or no pain.

A case of carcinoma of the larynx, treated in February, 1915, when the disease was well advanced, has been perfectly well up to this time, with nothing of the trouble remaining except a little huskiness of voice. The list shows recovery in several throat cases, although the three-year period has not expired. Carcinoma of the esophagus has been given special study, and, considering the inaccessibility and irritability of the surrounding tissues, the results have been surprisingly good. It is hoped that, by improved technic, at least the esophageal cases treated early can be relieved. While in no instance was the disease eradicated, there were two out of eight cases which so far improved as to be able to eat solid food, and one case is still living. Results in the treatment of keloid conditions of the esophagus have been exceptionally good, as a rule.

Carcinoma of the uterus, for which radium was used in previous years only in hopelessly advanced stages, is showing improved results as the cases are treated earlier. The effect on other pelvic structures has not been so good, although several cases of malignancy of the bladder and urethra have shown marked improvement. A case of epithelioma of the urethra treated in December, 1915, still remains in perfect health. Several rectal cases have been under observation, one for three years and one for five. One case which had advanced to profuse bleeding, shows a hard fibrous ring, and while there is still some disease, there is freedom from bleeding and the patient is comfortable.

Mouth cases, though obviously difficult, especially when the disease has attacked the tongue or alveolar portion of the jaw, have shown

good results when treated before the tissues had been severely injured. Epitheliomas upon the face, when they occur on the lip, the ala of the nose, and the mucocutaneous junction of the eyelid, show marked tendency to recur after other treatment, and appear to react better to radium. The recurrence in scar tissue is always more serious.

Several cases of sarcoma treated in previous years still remain under observation. Sarcoma involving the sacrum, in a girl ten years old, disappeared under radium treatment, and the bone structure which had been destroyed was restored. Another case was sarcoma of the antrum which had displaced the eye, upward and outward, the whole side of the face being swollen and the roof of the mouth being displaced downward. For two years patient has enjoyed good health, the only permanent injury being a hole between the nose and mouth, covered by a plate similar to that used for false teeth.

Of the benign cases, the most interesting are reported to be those of uterine fibroid and hemorrhage due to various causes sometimes difficult to determine, and which, especially where there is profound anemia, heart, kidney or lung complication, are inoperable. Radium has controlled the hemorrhage and enabled patient to recover from debility, so that further corrective measures were possible. These cases the author finds, have enlarged the field of radium to such a degree that it is almost supplanting older forms of treatment. Several of the inoperable fibroid cases treated in 1915 have remained under observation with no show of further trouble.

In this report is incorporated one submitted by Dr. P. Brooke Bland, in which 22 uterine cases, classified nonmalignant, were treated to control hemorrhage. In all a cure was accomplished, one application being sufficient in all but one, who, suffering with large multiple fibroid tumors of the uterus and being too profoundly anemic to withstand operation, required three treatments of 2400 mgrs. of radium. Forty-five inoperable cases of malignant disease showed three cures; symptoms, hemorrhage, discharge and pain were relieved; recession of the superficial portion of the tumor was observed in all; inhibition of the growth was noted and in each occurred a marked improvement of the general health.

Cases of angiomas, treated in 1915 and 1916 have shown ideal results where proper care was taken. A few tuberculous lesions have been treated. Where a nodule, supposed to be tuberculous or inflammatory is treated and disappears rapidly, the results show that it should be regarded as a sarcoma until proved otherwise. Tuberculous nodules as a rule reduce slowly and leave a small, hard scar. A case of tuberculous sinus of the chest wall, of several years' standing, which had failed to respond to other treatment was so far healed by radium that the man (a physician) was able to serve through the late war in active field duty. In cases of enlarged glands the results do not seem to differ materially as between radium and x-ray treatment.

All cases covered by this report were treated by the crossfire method, care being taken to guard against too severe reaction in the skin and in the mucous membrane of the larynx, which appears to be especially susceptible to radiation.

Value and Limitations of Radium and Roentgen Rays in the Treatment of Disease.

R. H. Boggs, M. Council, 25:377-82, May, 1920.

Both forms of radiation (radium and x-ray) have the so-called selective and inflammatory action if given with sufficient intensity, but with radium a reaction of greater degree can be produced without permanently injuring healthy tissues than with the Roentgen rays. Therefore, radium can be used therapeutically with greater destructive power locally than the Roentgen rays, but great care must be exercised, particularly if cosmetic results are desired. This explains why radium is superior in treatment of cancer of the uterus and rectum, epitheliomata of the lip, mouth, throat, eyelids or lesions situated on the mucous membrane as well as its ease of application in cavities. It is universally conceded that radium or the Roentgen rays is the method of choice in treatment of epithelioma, but radium has certain advantages, one being that it can be inserted in the diseased tissue. Cases of the above type, especially epithelioma of the lower lip, are usually inoperable because of the frequent recurrence in the scar, and because in cases involving some of the adjacent lymphatic glands, operation on these glands cannot be sufficiently complete, no matter how thorough the dissection.

Radium is indicated as a palliative measure in hopeless, inoperable and recurrent cases. Lately radium is being used for primary cases in carcinoma of the cervix when the disease extends into the cervical canal. Radium is a specific palliative in inoperable cancer of the uterus. It will clinically cure about one-third of the cases and subjective improvement is noticed in a certain percentage of the others. However, recurrence takes place in many of these clinically cured cases within two or three years.

Formerly it was thought that the therapeutic action of both radium and the Roentgen rays was due solely to action on the ovaries, but it has been demonstrated that radium applied locally destroys the endometrium and endothelial cells of the capillaries, leading to their obliteration. Schmitz claims that the symptoms of change of life are milder after radium than after Roentgen treatment. After radiation the menopause ceases gradually and without the usual disturbances, such as violent flushing, sweats, palpitation, etc., which frequently accompany normal change of life.

Radium and Radium Salts.

H. O. Sterns, physicist to the Mayo Clinic. Am. J. Elect. & Rad., 38: 169, 1920.

Radium is a bivalent metallic element closely related to barium; it is very active chemically and consequently difficult to isolate in its metallic state and after isolation to keep pure as it reacts with air, forming the oxide and nitride and finally the carbonate. On account of this activity it is produced only in the form of its salts, principally the soluble bromide, chloride, and the insoluble carbonate and sulphate.

Actions and uses: Solutions of radium or radium emanation are said to increase the excretion of uric acid in the urine in some cases and to decrease its concentration in the blood; to increase somewhat the

number of red blood corpuscles; to cause temporary leukocytosis early in the course of treatment, the mononuclear increase being relatively greater:—no appreciable benefit is observed in leukemia. It is said that radium increases general metabolism, and in vitro activities certain enzymes, pepsin, pancreatin, rennin, autolytic ferments, tyrosinase and diastase.

It has been claimed that radium emanation is of value in all forms of non-suppurative, acute, subacute and chronic arthritis (luetie and tuberculous excepted), in chronic muscle and joint rheumatism (so called) in arthritis deformans, in acute and chronic gout, in neuralgia, sciatica, lumbago, and in tabes dorsalis for the relief of lancinating pains. Its chief value is in the relief of pain.

The relief of pain is well established; in consequence, improvement is sometimes observed but curative results appear to be lacking. Due consideration should be exercised in judging the favorable reports published.

Physicians should realize that the emanation following the giving of an emanation solution (such as that from radio-active water generators) is very soon lost from the body (large proportion also escapes during the process of drinking); whereas a radium solution leaves a large part of its radium content in the system to be slowly excreted in the course of several months. For this reason, radium solutions produce a condition of radio-activity in the body for a longer period than emanation preparations. It is not desirable therefore to consider the latter equivalent therapeutically to a radium solution which is capable of producing the same equilibrium amount of emanation.

Dosage: Radium may be administered as baths, by subcutaneous injection in the neighborhood of an involved joint (0.25 to 0.5 microgram in 1 or 2 c.c. distilled water), by local application as compresses (from 5-10 micrograms), by mouth as a drink cure (in increasing doses of from 1-10 micrograms three or more times a day), by drinking radio-active water, containing only radium emanation (from 2-20 microcuries of emanation, or more in 24 hours), by inhalation of the emanation, the patient for two hours daily remaining in the emanatorium which contains 0.0025 to 0.25 (average 0.1) microcurie of emanations per liter of air. The Council will not accept any radium solution for internal use, the dosage of which is less than two micrograms per day, nor any radium emanation generator which yields less than two microcuries of emanation per twenty-four hours.

A Lecture on the Technique of the After-Treatment of War Injuries by Radium.

W. C. Stevenson, Med. Press & Circ., 1:27, 1919.

In 1914 the author treated with radium emanation needles a patient having an extensive scar on the wrist due to an old deep burn which caused a painful and rigid hand. In less than a week marked improvement in the utility of the hand resulted, due to some freeing of the tendons to the fingers, decreased tenderness, and general betterment of the nutrition of the hand as a whole.

Since 1917 the author has treated about 300 military patients by the surface application of radium emanation, and it has been very exceptional not to produce rapidly some improvement, in cases which often for long periods have been unaffected by other methods, such as massage, ionization, whirlpool baths, etc.

After giving some data on radium in general, the author comes to the clinical consideration in dosage. Rays from radium come out in every direction, and the intensity of radiation according to the distance from their source is governed by laws similar to those of light. Hard gamma rays will traverse the whole human body. Therefore when radium is applied to opposite sides of a limb this fact must be taken into consideration and the dose per skin area reduced somewhat, especially in the case of thin parts, such as the fingers and hand. For the same reason, when adjacent skin areas are treated, the dose per area should be less, especially in the central areas. As in the case of septic infection, bulky parts like the thigh or arm, where there is more accommodation for vascular changes, will stand a larger dose than the hand, the immediate neighborhood of the knee, and over subcutaneous bone generally. Then parts affected by trophic changes should be given small doses.

Dosage according to object of treatment: The largest doses are required to free scar tissue due to the physiological organization of granulation tissue following gunshot wounds and sepsis. About half this dose is adequate to deal with adhesion in joints and round tendons. For a purely analgesic effect on a tender scar where the nerve endings are involved an eighth or less of the full dose is usually sufficient.

The standard applicator used by the author is a lead box consisting of two shallow trays fitting into each other, made of 4 pounds to the square foot commercial lead sheeting containing radium emanation in glass capillaries.

Measurements: Lead, 1.57 mm. thick; area of bottom of box, 2 x 3 cm.; depth, 3 cm.

The box is completely surrounded by six layers of paper, two to three mm. thickness of cotton wool, and the whole made into a packet about 4 x 5 cm. with sticking plaster.

The lead cuts off all the soft rays from the radium, while the covering is absolutely essential to cut off secondary soft rays produced in the lead by the rays from radium.

Dose of radium emanation for surface application: The author has found by experience in cancer cases that by using the applicator just described, over one area of skin, epilation, erythema, or ulceration of the skin will occur in two or three weeks if the emanation is left on till its activity has been reduced by 3.2 millicuries, for convenience called a dose of 3.2 millicuries. A dose of 3.2 millicuries is therefore a safe dose for one area of skin in most circumstances. Skin with trophic changes due to nerve involvement is very susceptible to radium burns, and a third to a half of this dose should be the maximum.

Dose of radium emanation for surface application using standard screen:—1.5 mm. lead, wool, etc., area 2 x 3, distance from skin 0.5 cm. (due to wool, etc.). Dose causing ulceration 3.2 millicuries.

For the treatment of gross scars.

Over 1 area of skin	2.2 to 2.5 mc.
Over 2 adjacent areas of skin	Total 2.8 to 3.2 mc.
Over 3 adjacent areas of skin	Total 3.2 to 4.0 mc.
Over 4 adjacent areas of skin	Total 4.0 to 5.0 mc.
Over 5 adjacent areas of skin	Total 5.0 to 5.5 mc.
Over 6 adjacent areas of skin	Total 5.5 to 6.0 mc.

Knee, elbow, ankle.

Over 1 area	2.0 to 2.2 mc.
Over 2 adjacent areas	2.5 to 3.0 mc.
Over 3 adjacent areas	3.0 to 3.5 mc.
Over 4 adjacent areas	3.5 to 4.0 mc.
Over 5 adjacent areas	4.0 to 4.5 mc.

On hands and feet.

Over 1 area	1.5 to 1.7 mc.
Over 2 adjacent areas	2.2 to 2.5 mc.
Over 3 adjacent areas	2.5 to 3.0 mc.

Note:—In cases of hand and foot and thin forearms, skin surfaces diametrically opposite one another should be considered as adjacent areas.

For the treatment of old teno-synovitis and adhesions due to injury and disuse.

Hand:—Between fingers:—0.3 to 0.7 mc. each interdigital space. Total 1.0 to 2.1 mc. Two areas palm and two areas back of hand:—0.5 to 1.0 mc. each. Total 2.0 to 4.0 mc. Front and back of wrist:—0.6 to 1.6 mc. each. Total 1.2 to 3.2 mc. Total for hand and wrist:—4.0 to 9.5 mc.

Elbow:—3.5 mc. for 3 areas; 4.0 mc. for 4 areas.

Shoulder:—6 mc. for 5 areas.

Knee:—7 mc. for 7 areas.

Ankle:—4 mc. for 4 areas; 4.8 mc. for 5 areas.

Foot:—3 on dorsum, 3 on plantar surface. Total 4.5 to 5.0 mc.

For tender scars due to involvement of nerve endings, 0.5 to 0.7 mc. per area of skin. Similar doses should be given over nerves and nerve plexuses and arteries with their sympathetic nerve supply in the neighborhood of wound scars with the object of stimulating nerves to perform normal functions, and to overcome "partial nerve block."

Interval at which treatment may be repeated.

For scars:—After 4 to 6 weeks. Four treatments in six months.

For painful scars:—After 2 to 5 weeks.

For teno-synovitis hand:—With 4.0 mc. dose. Repeat in 14 days, 21, 28 days, and every month until 6 doses administered. With 9.5 mc. dose, as for scars.

Note:—Except where there is extensive and deep scarring, as in the thigh, where fairly large doses are required, apparently as good results may be obtained by small doses more frequently repeated as with large doses. On the whole, it is a mistake to think that the best results will be obtained by maximum doses, and it is better, when in doubt, to decrease the dose in military orthopedic cases, when one is not dealing with malignant tumors or even benign growths like keloids but with cells and tissues which are the normal consequence of inflammation directly or indirectly due to trauma.

Internal Use of Radium.

D. C. Moriarta, Med. Rec., 94: 586, Oct. 5, 1918.

The author states, "Whether the action of radium, when administered internally, is autolytic, catalytic, or by its electrical force exerted on the individual cell, is beyond my determination. But I do know from my laboratory findings that radium promptly and invariably increases the number of red blood cells. From this single finding it is obvious that the remedy is a potent one and must of necessity augment all of Nature's processes, no matter how complex they may be."

The author commenced radium treatment with 15 milligrams of the element in the form of a soluble chloride, 10 milligrams for an emanatorium, and 5 milligrams with which to activate water. The author has continued its use regularly in his practice since that time, as opportunity presented, with many successes and few disappointments.

In the first cases treated by radium by the author he decided to omit all other measures, and to determine the merits attributed to radium. The following points were determined in each instance: (1) Blood pressure; (2) blood count; (3) urine: (A) quantity; (B) specific gravity; (C) casts; (D) kidney efficiency (as determined by phenolsulphophthalein test).

The author's method of administration and dosage was essentially the same in all cases; clinical conditions did not govern dosage. Each case was treated daily for a period of six weeks; in the emanatorium for two hours, where there were 270 Maché units of radium emanation to a liter of air, with varying quantities of activated water, internally, usually a half liter which contained 113,000 Maché units to the liter, and some of the cases also had intravenous injections of radium salts. Three of the cases developed a marked reaction from the treatment (without intravenous injections) which was manifested by increased pulse rate, temperature, nausea and vomiting, and great prostration, lasting in each case about forty-eight hours. On resuming the treatment, a second reaction occurred in two of them. The author finally succeeded in establishing a tolerance for radium in these cases by commencing with a very small dose and gradually increasing it. The number of cases observed was 19, of which there were: 2 gout, 2 arthritis deformans, 3 diabetes, 2 intermittent claudication, 11 cardiovascular-renal disease. The 2 cases of gout were old ones; both were enthusiastic over the remedy, stating that the attacks were of shorter duration and less painful.

The cases of *arthritis deformans* were decidedly improved, particularly as to the relief of pain, the diminished swelling in the joints, and the increased action. In one of these cases the author was too anxious, and used 40 micrograms intravenously, in addition to the usual procedure. The patient became very ill and in a few hours practically collapsed; blood pressure dropped from 230 to 110 Mm. Hg. Stimulants and pituitary extract were administered, and after twenty-four hours she was all right, except for malaise.

The cases of *diabetes* were negative, except for lowered blood pressure and in increased red blood count.

The cases of *intermittent claudication* were relieved, that is, the attacks of pain subsided and remained quiescent for about eight weeks.

The eleven cases of *cardiovascular-renal* degeneration were all rather advanced; yet notwithstanding this fact, they all took on a feel-

ing of well-being and comfort, and the dyspnea, blood pressure and kidney elimination were unquestionably modified. Though the number of cases treated was only 19, yet the following facts stand out so constantly that the author accepts them: (1) general feeling of well-being and betterment; (2) diminished blood pressure; (3) increased kidney efficiency; (4) decided increase in number of red blood cells, varying from 150,000 to 1,500,000.

The prognosis naturally depends upon how far the pathological process has developed. Treatment must be prolonged, as radium is largely indicated in chronic morbid conditions, in which the balance is not only difficult to establish, but in which it is also easily upset.

Radium in Internal Medicine.

W. S. Newcomet, Radium and Radiotherapy, 1914, pp. 1-309. Lea and Febiger, Chapt. XX.

Dosage depends somewhat upon desired effect but may be divided into two classes. First, those which call for slight exhilaration in the physiological forces, and second, those which call for a profound effect. In the former, baths, drinking water, and the breathing of relatively small amounts of radioactive water or air are employed, and continued for some time. A month or two before cessation, then after an intermission of a few weeks or a month, another course begins, and this regimen is continued until the desired result is obtained or the treatment for some reason is abandoned.

Changes are often observed in the blood, particularly in the beginning, when there may be a decided leukocytosis. This may be influenced by the action of these radiocative salts upon the bone marrow, where it is supposed to be stored. The blood pressure often rises abruptly, then gradually sinks until it goes below normal and remains there for an indefinite period depending upon the dosage.

In diabetes mellitus the influence upon metabolism is reported to have caused to some extent a lessening of the glycosuria. This was accomplished by drinking water containing a high percentage of emanation. The influence in lessening the pain that often accompanies the neuritis in these cases was also quite marked.

Anemia: In the various forms of anemias, both primary and secondary, radium may be found of value in conjunction with iron and other forms of treatment, especially in these cases where there is a decided splenic involvement; or where the lymph glands are enlarged as in tuberculosis of these glands.

Caution should always be taken in the administration of radium internally in all cases of low vitality; in severe grades of anemia; heart disease of various forms; and care should be taken also in treating women about the time of the menopause.

Thorium in internal medicine:—

Anemias: Both the primary and the secondary forms are most decidedly benefited by these radioactive elements.

In *pernicious anemia* these radioactive elements have in some instances produced an increase in the blood supply for a temporary period.

The more severe grades of anemias are all treated by hypodermic or intravenous injection, the strength of the solution varying with the judgment of the observer, as no standard has been established.

Leukemia—both the lymphatic and myelogenic varieties—has been treated by all forms of radiation and often temporarily benefited, and if under some conditions one form of radiation fails, this is no indication that the other will not prove beneficial.

The fact is frequently observed that in cases where the Roentgen rays produce no improvement, they will be singularly influenced by these radioactive elements; and in those cases of myelogenic leukemia where the spleen is greatly enlarged, powerful applications of mesothorium will reduce this organ considerably, with the same improvement in the general symptoms.

In certain forms of acute arthritis of the specific type, or a very acute exacerbation of an old process, treatment should not be undertaken until it has subsided into the more chronic form. With the exclusion of these few contraindications, treatment, if well regulated and used moderately, will, as a rule, be attended with success.

Cameron reports a list of 66 cases treated, and he divides the cases into *acute*, *subacute*, and *chronic* stages.

	Number treated	Not improved	Improved	Cured	Still under treatment	Discontinued during treatment
Acute primary infectious arthritis.....	....	....	....	....	....	....
Subacute primary infectious arthritis....	5	....	....	5	....	....
Chronic primary infectious arthritis.....	4	....	....	2	....	2
Acute secondary infectious arthritis.....	3	....	1	....	....	2
Subacute secondary infectious arthritis..	14	1	1	7	2	3
Chronic secondary infectious arthritis...	17	1	2	2	5	7
Acute primary infectious arthritis.....	....	....	....	....	....	....
Subacute primary infectious arthritis....	3	....	....	3	....	....
Chronic primary infectious arthritis.....	6	1	1	2	1	1
Acute secondary infectious arthritis.....	....	....	....	....	....	....
Subacute secondary infectious arthritis..	2	....	1	....	....	1
Chronic secondary infectious arthritis...	12	4	2	2	3	1
Total	66	7	8	23	11	17

Note: Cases are placed in the acute stage when motion in the affected joint is not impaired other than by the acute inflammatory process, and when there is a constant temperature curve.

Subacute stage: When the joint can be moved by voluntary or passive motion without causing additional or recurring local inflammatory symptoms or fluctuations in temperature.

Chronic stage: When degenerated or organized exudates cause fixation and deformity.

The method of treatment outlined in these cases was the inspiration of 0.025 to 0.1 microcuries per liter of air, in an emanation room for at least one and one-half hours each day; with this, 1 liter of emanation drinking water containing 15-20 microcuries per liter, which may be divided into four doses. This procedure is recommended in acute cases. Where they tend to a more chronic character it is necessary to carry large amounts of the emanation into the system by more and stronger emanation waters, and also by the inspiration of charged air for a longer period. If, however, the patient is not benefited in a period of sixty days, usually the case can be regarded as one not suited to this form of treatment.

Arthritis of gonorrheal origin is often benefited by the local application of radium, and even in the later stages, where considerable exudates have been thrown out about the joint, much relief is afforded by the absorption of the products of inflammation.

Arthritis of specific origin is not benefited to a degree worth considering.

Chronic rheumatic arthritis of different types may be relieved and to some extent the fibrous exudate may be absorbed. Where, however, there has been absorption of the joint surfaces, with erosion, the outlook is more or less hopeless; though it may be possible even under the circumstances to soften the process to some extent and allow the limbs to be placed in better position. Both the local and internal use of radium is employed in these cases; the emanation taken internally by breathing charged air, or the sipping of emanation water; locally by baths, packs etc.

The emanation of radium is employed in doses of 100 to 1,200 Maché units per liter per day. In those cases where these applications cause a rise of temperature, caution must be exercised.

Arthritis deformans, one of the most rebellious forms of joint manifestation, has to some extent been strikingly benefited by the use of radium. Pinch (London Radium Institute) has adopted the following technique in the treatment of cases in that institution: The individual receives 250 c.c. of radium emanation solution of a strength varying from 1-2 microcuries per liter each day and this form of treatment must be continued for a long time. Out of a series of 21 cases, 1 was cured, 9 improved, 5 did not improve, 1 abandoned treatment, 1 was rejected, while 4 still continue under active treatment.

Radium and the Roentgen Rays in Radiotherapy; Their Uses and Limitations.

W. S. Newcomet, J. A. M. A., 63:743-47, Aug. 29, 1914.

Rays generated from a Crooke's tube may be considered as being identical with those eliminated from radium, varying somewhat, however in regard to force. The cathode and beta ray seem to be analogous; the two have the same properties except in regard to speed. While the cathode ray travels 5,000 miles a second, either from or impinging on

the surface of the anode, causing the formation of Roentgen rays, the beta ray is disrupted or exploded from the atom of one of these radio-active salts and leaves it at a rate of from 45,000 to 100,000 miles a second, generating during this disturbance the gamma ray. It is obvious that when we have a force of 5,000 miles a second on one side, with another of from 45,000 to 100,000 on the other, the results must necessarily differ. A comparison of this with a large number of bullets being projected from or impinging on a surface, in one instance the force being from nine to twenty times greater than the other, gives us an analogy. It follows that the gamma ray has far greater penetrating powers than any Roentgen ray so far known, and, while it may be possible to build a Roentgen tube that will give the required speed of the cathode particle, as yet (1914) it has not been produced and there is no likelihood of its being accomplished.

Physiologically the difference between high and low radiation is of greatest importance. While the low rays are always most active they lack penetration, and it is well known that the so-called burn is likely to follow their indiscriminate use. Therefore they are not so desirable as the higher rays, which possess penetration and are by no means so active in producing tissue change. This point may seem somewhat contradictory, but on analysis it will be found that experience and theory support each other. Let it be taken for granted that, as these active low rays pass through tissue, a cell here and there feels the full force of the radiation, while others are protected. This gives rise to a process in which may be found conditions varying from stimulation on the one hand to necrosis on the other, whereas, under the influence of the high radiation, the effects are more uniform, each cell receiving an equal amount of radiation. If this be true macroscopically, then why not apply the same microscopically. For instance, the important part of the cell is its nucleus; therefore, if the radiation is obstructed by the cell elements, the nucleus, being protected by them, naturally escapes; this causes an inflammatory reaction, but it is doubtful if it results in the death of the cell. On the other hand, if the radiation is high, all parts of the cell receive about the same amount of radiation and this causes an equal amount of degeneration in all parts and consequent death of the nucleus. Therefore the high rays should prove most desirable as a therapeutic agent.

A second difference between the Roentgen radiation and that of these radio-active elements is that there is not the least doubt that with the gamma ray is carried a fairly large proportion of high beta rays, which, although thought to be useless, have from an experimental point of view a pronounced physiological significance, and it may be possible that, as these gamma rays are projected through the tissues, the formation of secondary beta rays may cause the more active change in tissues so commonly seen in reactions from radium. This may be due to another condition, which is possibly secondary but plays a distinct rôle in the issue between Roentgen and natural radiation: When the former is employed, the point of origin of the rays is usually from ten to twenty inches from the body, and in this bundle of rays is a wide variation of one variety, a high tube containing a predominance of high rays, while in a low tube the opposite condition prevails. This, however, suffers modification between limits.

The mode of application of these radio-active elements differs from that of the Roentgen rays; for instance, the radio-active salt is usually applied to the affected part in close proximity to the disease; therefore, we have a given amount of high-penetrating rays springing from a point near, and not at a distance, as is usual in Roentgen radiation. This point is of more material interest if several sittings are given, for, should there be an tissue between the diseased portion and the radio-active salt, it is not likely to receive the activity at more than one sitting.

Another point, brought out in Bayet's work, is that the dosage of these radio-active elements can be measured with an exactness absolutely impossible in Roentgen radiation, and, while this is true to a great extent, the variation in the amount of radiation from a Crooke's tube is not of sufficient importance to cause it to be made an issue. Furthermore, the idiosyncrasies that exist to both forms of radiation cause more anxiety and are more important than the slight variation in dosage.

From the physical difference existing between these two forms of radiation, it would be expected that the effect on tissue would also be materially altered; and this view is substantiated by observation. It might be said that the reaction produced by these radio-active salts is decidedly more intense, is usually confined to a limited area, and is in turn followed by a fairly rapid restoration of the part; the same degree of reaction produced by the Roentgen ray would be more wide-spread, the damage to the tissue in the affected part more uniform, and healing extremely slow.

Even the reaction of a chronic character caused by these radio-active elements will rapidly disappear if the process has not been allowed to progress too far, while the same amount of damage done by the Roentgen ray would produce results that might last a lifetime.

Curiously, however, the varying susceptibility to these radio-active elements seems to be in greater proportion than to the Roentgen radiation. Many observers have called attention to the severe reaction that is frequently seen; it is most alarming when it occurs, and is likely to cause considerable anxiety. In a person of good physique it is not likely to result seriously, but in the weak and debilitated it may lead to serious consequences; the intense, rapid inflammation may lead to an extensive cellulitis, with its train of concurring symptoms, and usually follows the course natural to that condition, quite in contrast to the application of the Roentgen ray. On the other hand, cases are often seen in which it appears to be quite impossible to produce the expected reaction, and the tolerance almost borders on immunity.

The fact that Roentgen burns have been treated and healed by radium is sufficient to prove their wide variation.

In cancer of the uterus, radium seems to possess a control not observed with any other form of treatment, and while rarely permanent, gives comfort to the patient and materially alters the course of the disease.

These elements can be applied in cavities in which it is impossible to bring the radiation from the Roentgen tube without penetrating the intervening tissue, and it is in this field that the results seem to be somewhat better than those from the Roentgen ray. Such conditions as polypi of the larynx can be treated without injury that leaves the imprint of previous treatment on the overlying skin. In some instances, car-

cinoma of the palate and others of the buccal mucous membrane have been healed. The cosmetic results are exceptionally good, and possibly in those cases in which the Roentgen rays have failed radium often promotes the desired results. In deep cancer the choice between massive doses of deep radiation and the employment of these radio-active elements must be considered an open question.

The comparison of dosage between these two forms of radiation is an impossibility. The existing difference in their physical nature, their physiologic action and the mode of application does not permit it. The wide difference of opinion existing between individuals using the same form of radiation makes it difficult to analyze results, which in all events depend largely upon the manner and skill of employment rather than the quality and quantity of apparatus. Therefore at present dosage in all fields of radiation is a variable quantity that must depend entirely upon the opinion of the operator.

Radium in Internal Medicine.

L. G. Rowntree and W. A. Bactjer, J. A. M. A., 612:1438-1442, Oct. 18, 1913.

Radium as a drink cure: Radium emanation in solution is administered by mouth by varying and increasing doses (330, 1,000, 2,500, 5,000 10,000 Maché units), repeated three times a day. Lazarus has introduced a sipping cure in which small amounts of radium emanation are drunk many times during the day, thus keeping a certain amount of the emanation constantly present in the body. This method is well adapted for general use.

As inhalations: This is the best but also the most expensive method of administration.

Indications: The value of radium is unquestionably established in chronic and subacute arthritis of all kinds (luetic and tuberculous excepted), acute, subacute and chronic joint and muscular rheumatism (so-called), in gout, sciatica, neuralgia, polyneuritis, lumbago, and the lancinating pain of tabes.

Table 9:—Summary of results of radium treatment in various groups studied.

<i>Diseases</i>	<i>No. of Cases</i>	<i>Improved</i>
1. Chronic arthritis	411	371
Arthritis deformans	24	16
Muscular rheumatism	59	49
2. Gout	166	86
3. Neuralgia	59	47
4. Sciatica	115	91
Lumbago	5	4
Polyneuritis	8	8
Neuritis	5	2
5. Miscellaneous	186	163
Total	1,038	837

On the Use of Radium for Local Application Within the Body.
A. C. Jordan, Lancet, 2: 1742, 1909.

In the interior of the body, as the mouth, throat, esophagus, rectum or uterus, there seems to be a very real indication for the use of radium. The author describes a method devised for this purpose. He uses radium emanation in sealed glass tubes. The emanation is obtained from a solution of 400 milligrams of radium bromide. The solution is kept in a flask to which is attached a Töpler air-pump. The air in the flask is kept partially exhausted, and whenever any radium is required the pump is worked until the pressure is so low that the solution commences to boil. Radium emanation is carried with the water-vapor and residual traces of air into the tube leading out of the flask; this may then be collected in a small length of glass tubing inverted over a cup of mercury, and the tubing sealed in the flame. Thus the original stock solution is never touched. The radio-activity of the emanation tube begins to decay, so that in about four days it has lost half its radio-activity. But while the emanation in the sealed tube is decaying, the original radium (which had lost an equivalent amount of radioactivity) is recovering. With a stock solution of 400 milligrams of radium bromid, about 40 milligrams of emanation can be withdrawn daily without diminishing the value of the solution.

Every glass tube of emanation is enclosed in a length of lead "compo" tubing, the ends of the metal being closed down over the glass, rounded off, and welded up. All the soft beta rays are absorbed in this metal (the alpha rays cannot penetrate the glass) while some of the hard beta rays and practically all the gamma rays are able to escape. The metal tubing is put in a rubber tube the ends of which are closed by a silk ligature, a considerable length of silk being left attached to one end. The tube is then ready for insertion into the rectum or cervix uteri in a case of recurrent or inoperable carcinoma. A 10 milligram tube may be left in situ indefinitely (all night and through a greater part of the day) without fear of producing any destructive action on the normal tissues.

An advantage in using sealed tubes of emanation over glass tubes containing crystals of radium bromide is that there is considerable risk of losing a valuable tube of radium crystals if it be left in the rectum, while the loss of a tube of emanation is not serious. Another advantage is that the whole length of an emanation tube is uniformly radio-active, while the crystals fall to one end of the tube. The author wishes to impress the fact that this method is exactly the same in its nature as the use of crystals of radium bromide in sealed tubes, while being more convenient and not involving the risk of losing valuable tubes of radium salts.

Considering the enormous energy given out by radium, and considering that the alpha rays possess about a hundred times as much energy as the beta and gamma rays together it is obviously a matter of great importance to decide whether it is not possible to use the alpha radiation in treatment. This can be accomplished by exposing a negatively charged conductor—for example, a wire—to the emanation in order to concentrate the maximum possible quantity of active deposit on its surface. Thus, surfaces are obtained whose activity per unit area is enormously greater than could be obtained in any other way.

Needles thus rendered active could be inserted in malignant growths and exert all their energy. As the needles decay to half-value in about twenty minutes they would have to be recharged and could be reinserted into another part of the growth.

Influencing the Rapidity of Oxidation of Red Blood Corpuscles by Potassium and Radioactivity.

Philipp Ellinger, Hoppe-Seyler's Ztschr. f. physiol. Chem., 116: 266, Berlin, Oct. 22, 1921.

Potassium plays a part in maintaining the ion equilibrium in body fluids, and possesses radioactive properties. It sends out beta and gamma rays, of which the former rays show especially great penetrating power. Bird blood-cells were used to determine the power of oxidation. Intact erythrocytes do not permit cations to pass, so that the rapidity of oxidation is practically uninfluenced by changes in the cation content of the medium. The bird corpuscles are washed in the centrifuge, allowed to freeze at -2° , thawed, mixed with the examining fluid, and oxidizing power of the cell-suspension is determined by Barkoft's method. As controls, the same kind of blood corpuscles were suspended in Ringer's solution, both with and without potassium. The glassware used was approximately the same size, so that the results read off in millimeters on the manometer were comparable, after correcting for the thermobarometer. Temperature of the thermostat was 37° - 39° . The published tables show that the presence of potassium in the medium is absolutely essential for the oxygen respiration of the blood cells. When the amount of potassium reaches a very low level, the oxidation power falls about $\frac{1}{3}$, while an increase in potassium raises it. It is undecided whether the influence of potassium depends upon the ion or upon the radiation. Potassium can be replaced by rubidium but not by cesium. The rays are not capable of replacing a lack of potassium. The emanation cannot accelerate the oxidation process. Fluorescin, even in small amounts, hinders respiration, while eosin in small doses furthers, and in large doses hinders it. The furthering action seems to be independent of the potassium action, and immediate. It has not yet been shown that other radio-active elements can replace potassium.

The factor of Emanation in Radio-Active Baths.

W. Mittenzwey, Deutsch. med. Wchnschr., 47: 961, Berlin, Aug. 18, 1921.

Observations of the effects of radium baths on 636 patients at Oberschlenma are recorded; one spring of 640 daily liters contains 3,200 Maché units for drinking purposes, others contain 250 to 900 Maché units per liter and an emanatorium for inhalation purposes contains 15 to 25 Maché units per liter of air. The indications for treatment are the same as those for Wildbad and Gastein.

In chronic arthritis, pain was markedly diminished and function improved in the inflammations remaining in the periarticular tissues after acute joint rheumatism, also in primary chronic polyarthritis with capsular hypertrophy and exudation, but less favorable results were seen in

the more chronic cases with capsular shrinking and cartilaginous destruction; ankyloses and cicatricial changes were improved; the smaller joints showed better results than the larger ones.

Unfavorable effects were seen on the heart, vascular and nervous systems. Careful dosage is required in myocarditis associated with congestion phenomena; slight disturbances of cardiac activity were favorably influenced, especially from the improved diuresis. In arteriosclerosis the blood-pressure sinks; if the pressure sinks 50 or more mm. it can be used as a differential diagnostic measure in the presence of vasomotor disturbances of the sympathetic or hyperfunctioning endocrine glands; primary hypertension can be distinguished from the secondary form. The effects in pure sclerosis and presclerosis can be determined early and are available prognostically in cases of increased resistance in the arteriocapillary system, but less definitely when neurasthenia is a complication. The best results obtain in the field of nerve pains, as in true postinfectious (grippe) neuritis and in acute rheumatic nerve pains, especially in sciatica, tabes, syphilitic diseases of the central nervous system and muscular rheumatism. Visible results obtain in psoriasis.

Local emanation radiotherapy is governed by the theory that weak dosage favors biochemical processes, strong ones inhibit and very strong doses destroy. The processes favorably influenced are metabolism, the general condition and all the basic processes of life. Only weak (250 Maché units) and strong (900 Maché units) were ordered. Poor results were seen with insufficient dosage, the best dosage being 200 to 1,000 Maché units. All other kinds of therapy were omitted. All the patients felt the need of rest after the treatment. Emanation therapy of 300 Maché units or more per liter of water is a stimulant and promotes the processes of life. It is indicated in disturbances of cellular and body metabolism such as the gouty-rheumatic diseases and senile phenomena. Diseases with increased metabolism, asthenia and circulatory disturbances are not suited to emanation therapy.

Radium in Internal Medicine.

A. H. Werner, Med. Summary, 41: 271, Feb., 1920.

The author states, "The use of radium in the treatment of internal disease is not quite old enough to give a full appreciation of its value as a therapeutic agent. The indications and contraindications have not been fully ascertained."

In discussing the method of inhaling radium and that of taking it in the form of a drink the author says, "I maintain that the inhalation of 20,000 Maché units is not equal in action to 10,000 Maché units in a drinking cure. On the other hand, we must assume that the cure in an emanation is equal to the drinking cure, especially in diseases of the joints. We have observed that in drinking cures with high doses of emanation (20,000 M.U.p.d.) no benefit was obtained by the patient, but the cure in the emanatorium brought full relief."

"The drinking cure, the inhalation cure and the radium baths all have their place in the treatment of internal diseases and it is for the physician to decide which will be of the greatest benefit to his patient, frequently a combination of all three is indicated.

"The influence of the emanation on the blood picture: My experiments in a very large material can be summarized as follows: In a great number of patients we see a very great leukocytosis; even pathological hyperleukocytosis can be increased. The increase can be higher than 80 per cent; however, the differential count may remain unchanged. In most cases we have a relative increase in the mononuclear cells and in some cases this may reach the extreme. Especially does this occur in the emanatorium treatment but may also happen in the drinking cure."

Cases. "A. H., forty years old; chronic progressive polyarthritis and psoriasis, white cells count 10,500. After two hours' treatment in the emanatorium, 100 Maché units per 1,000 c.c. of air, leukocytosis 19,180."

The emanation acts as a diuretic.

Radioactivity in Therapeutics.

J. B. Bissell, Med. Rec., 93: 142, 1918.

To particularize as to the lesions most amenable to radium therapy, there can be no question of its efficacy in certain benign and malignant skin lesions.

In relieving the skin cancers about the face radium is practically a certainty. This is fortunate, as in most neoplasms of this part of the body, the necessary surgical procedure is mutilating and leaves ugly deformities. Rodent ulcers are invariably cured if not too extensive, and even the larger ones are favorably affected if properly and persistently treated by radium applications. Neoplasms of the mucous surface of the lips and cheek have a high degree of malignancy and are an exception to this rule. Prophylactic treatment of suspicious growths or abrasions of the lip during the cancer age is advisable. Leucoplasia of the tongue responds favorably to scientifically applied doses of radium.

Recurring nodules in the skin following removal of cancerous breast should always be treated by radium. If the treatment is persisted in with proper dosage, it is usually successful. Often the nodules absorb only under quite severe radium burns. Inoperable lymphosarcoma of the neck and mediastinum fortunately disappears quite often under heavy radium applications. The results in some of these patients treated by radium are so astounding as to be almost incredible.

In inoperative uterine carcinoma of extensive recurrence radium offers practically the only hope. Where radium can be applied to the uterine canal in fairly large quantities, for a suitable period, where the immunological forces of the human tissues can still be stimulated, where the patient's resistance is not exhausted, and the toxemia is not too great, we may expect many favorable results. Radium is very useful many times in cervical and uterine hemorrhages following recurring malignant ulceration; where pressure, styptics, and packing fail, radium in large quantity may produce thromboses of the vessels and thus check the flow of blood.

Brilliant results are obtained in the treatment of fibroids of the uterus by the use of radium. The symptoms improve, the tumors decrease rapidly, the menstruation becomes regular and the patient is again a normal woman even to the extent of pregnancy if still in the child-bearing age.

Circumferential cancer of the rectum when inoperable is ideally located for treatment with radium, and numbers of such patients have been restored to health.

Striking cures of sarcoma of various types in the long bones are frequent in the author's experience. Notably a case seen with Dr. Sayre of spindle-cell origin in the head of the tibia in a young woman, 22 years of age, and also one in a boy of 18 years of age with a spindle-celled sarcoma of the femur, superiosteal origin, treated with Dr. Coley, are among the numerous ones seen in recent practice.

Physics and Chemistry for Medical Men.

A. Fernau, Wien. klin. Woch., 31: 1160, 1918.

1. Transformation products of radium.

Radium (atomic weight 226) gives off two inert gases: inactive helium (atomic weight 4) and radio-active radium emanation (atomic weight 222). All three emanations, radium, thorium, and actinium, are inert, monatomic gases. Radium emanation gives radium A which in turn gives off radium B, and this radium C, radium C', C'', radium D, radium E, radium F, and finally, radium G, inactive lead. Radium A, B, C, C', C'', have an induced activity lasting about three hours; a residual activity remains from which radium D, E, and F are produced. Radium A and radium F are isotopic with tellurium, Radium B and D with lead, radium C and E with bismuth. The lead obtained as the end product of uranium disintegration is chemically identical with ordinary lead, but also has a different atomic weight.

2. The rays of radioactive elements.

It is rather difficult to define a ray but the following is the least objectionable definition: the most rectilinear orbit or direction of transmission of any induced energy. The different kinds of rays are differentiated by the degrees in which they are absorbed, and are classified on this basis into soft and hard rays. Penetrability of the ray is dependent not only upon their velocity but also upon their mass.

X-rays are helium atoms minus two negative electrons, thrown off with a velocity equivalent to 1/10 that of light. Beta rays are negative electrons and are much lighter than alpha rays, and are similar to the cathode rays in Geissler tubes. Their mass is about 1800 times smaller than a hydrogen atom, and about 7000 times smaller than a helium atom. Therefore the beta rays have a much greater penetrability (hardness) than the alpha rays. Beta rays are not homogenous. It has been proven in magnetic fields that both alpha and beta rays have mass.

Gamma rays have no mass or charge, and possess therefore extraordinarily large powers of penetration, greater than that of the hardest roentgen rays. They are not completely absorbed by lead plates 20 cm. thick, their mean path is about 250 m., their hardness so great that they do not give sharp x-ray photographs.

The intensity of the rays varies inversely with the square of the distance. This should be borne in mind by the physician, especially in deep ray exposure.

Reference Handbook of the Medical Sciences.

T. L. Stedman, 7:466, 1917, 3rd ed. (Pac-Sto).

"The indications for the internal use of radium are vague and also the contraindications. Cases with severe endocarditis, pericarditis, delirium cordis, severe neurasthenia and hysteria, especially in the menopause, are given by Von Noorden as contraindications to the use of radium internally. The value of the medical uses of radium has been greatly exaggerated and reports are confusing. The great variations in dosage add to this. There seems no question, however, that benefit has been derived in certain forms of gout and chronic rheumatism and neuritis. The effect upon the hematopoietic tissues either stimulative or destructive must, however, be borne in mind. Improvement has also been reported in cases of pernicious anemia, leukemia, erythrocythemia and in hypertension; in the latter the blood pressure has been reduced to normal and the subjective symptoms are said to disappear.

Internal therapy by radioactive substances is still too recent to express a very decisive opinion regarding its value. The duration of favorable results reported is not known in most instances. There is need of more control cases and particularly of a large number of cases worked up in detail and followed to end results before certain conclusions may be drawn."

The Elimination of Soluble Radium Salts Taken Intravenously and per os.

Harvey A. Seil; N. Y. M. J., 101:896, May 1, 1915.

Radium taken into the body is continuously disintegrating with the formation of the gaseous radioactive substance, radium emanation. This gas is carried by the blood to the lungs, where the emanation passes out of the blood by diffusion, and is lost from the body in breathing.

Conclusions: Taken by mouth, a much greater part of a soluble radium salt is eliminated during the first three or four days, but after that, the rate of elimination is sensibly the same as when the radium is introduced by intravenous injection.

The main part of the radium is eliminated in the feces. When the radium is taken by mouth, a smaller proportion of the excreted radium is found in the urine than when the radium is injected intravenously. From 25 to 35 per cent of the radium taken by mouth remains in the body four to five days after ingestion.

Radium solutions taken repeatedly by mouth have a cumulative effect. However, the elimination of radium taken by mouth is about twice as rapid as when the radium is injected intravenously. Therefore, there will be required about twice as much radium to produce a given result when the radium is taken by mouth.

Search for Thorium in Cancerous Growths.

J. Joly, Scient. Proc. Roy. Dubl. Soc., 14:345, 1915.

In an article in the Practitioner, March 1914, Dr. Lazarus-Barlow records observations showing the presence in some cases of abnormally large quantities of radium in morbid tissues. His experiments refer to cancerous and malignant growths of various kinds.

These results may be very significant, for, of course, the radiations from the radio-active derivatives of radium are involved, and it has been shown by observation that feeble gamma radiation may accelerate the growth of such morbid tissues. Nor is it difficult to perceive a priori reasons for the influence of the rays when their remarkable ionizing powers are considered in connection with the chemical activities involved in metabolism.

Dr. Lazarus-Barlow's results are, however, by no means uniformly positive. The amount of radium present cannot in every case, be claimed as abnormal. This fact suggested the desirability of seeking for the presence of thorium in such growths.

Thorium is much more abundant in Nature than radium; in radio-activity, however, the amounts present of the two series—i. e. of the radium series of element and of the thorium series—do not differ seriously. Then if these elements are taken into the body, in amounts proportional to their relative abundance in the surface materials of the earth, their radio-active influence upon growth, etc., will be much alike in importance, and if by any processes segregation of these elements is equally promoted in any special organ, the effects will be similar in kind and degree. As nothing is known about the causes at work in the observed segregation of radium, it might well be that similar causes operated to segregate thorium; such causes might even operate in the latter case with greater efficiency than in the former. The author therefore proceeded to investigate and records some experiments.

The procedure adopted was to break up the tissues by maceration in strong HCl over the water-bath. An almost perfect solution was obtained in this way. The solution being dealt with is brought to such a dilution as to boil freely. It is enclosed in a flask, and during brisk ebullition a steady current of air is drawn through the flask above the surface of the boiling liquid, and thence passes through a condenser, and from this through drying tubes to a gold-leaf electroscope. The condenser removes the steam, etc., returning condensible vapors to the flask; the air is further dried in the short drying tubes and finally enters the electroscope with much of the thorium emanation still present.

If the normal rate of loss of charge by the leaf is accelerated, the significance of this acceleration is determined by adding to the boiling liquid a small known amount of a solution of thorium. The acceleration in the rate of collapse of the leaf produced by this enables the readings to be calibrated.

In this method the effects due to any radium present may be neglected if the precaution is taken of boiling off the radium emanation before connecting the flask to the condenser. This emanation only very slowly regenerates in the solution, while the regeneration of the thorium emanation is very fast.

The sensitiveness of the results to be recorded is determined by the following experiment:

Into one of the solutions, which had already been tested, and which possessed a bulk of 900 c.c.'s, a quantity of standard solution of thorianite was put, containing 16×10^5 gram of thorium element. The gain in rate of collapse of the leaf was 8 scale divisions per hour. Hence one scale division per hour indicates the presence of 2×10^5 gram of thorium. If the total weight of tissue dissolved in this solution had con-

tained as much as 2×10^5 gram of thorium, this would have accelerated the collapse of the leaf by one scale division per hour—an acceleration quite determinable.

The following experiments were made:

I. Cancer involving stomach and lymphatic glands. Examination of sections under microscope showed that about one-fifth part of stomach was actually composed of cancer-cells.

145 grams were heated in 200 c.c. strong HCl. The solution was made up to about 800 c.c. with distilled water. The whole solution was treated in the manner described above.

The electroscope, which had been steady at a rate of loss of 3 scale divisions per hour before ebullition began, maintained this rate unaltered. Hence thorium in amount greater than 2×10^5 gram, was not present. This amount would be about 1.4×10^7 gram per gram of tissue. The experiment does not bear on the presence of radium as the solution was vigorously boiled before attaching to the electroscope.

II. Liver in part replaced by cancer. Conclusion of this experiment is that more than 2×10^5 gram of thorium was certainly not present, i. e., about 8×10^8 gram per gram.

III. Sarcoma of ovary. Conclusion—No thorium was present in amount exceeding about 9×10^8 gram per gram.

IV. Myoma of uterus. Conclusion—No thorium exceeding 1.3×10^7 gram per gram.

V. Cancer of breast. Conclusion—No thorium exceeding 2.2×10^7 gram per gram.

VI. Sarcoma of knee. Conclusion—No thorium exceeding 2.5×10^7 gram per gram.

It is desirable that the above results—which, as will be seen, are consistently negative—should be extended. They possess a practical bearing, for if it can be shown that thorium introduced into the system is in every case, again eliminated while radium compounds remain stored or become segregated within the body, the use of thorium for internal administration would possess advantages over the use of radium.

A Preliminary Report on Uranium, Radium and Vanadium.

Richard B. Moore and Karl L. Kithil; Department of the Interior; Bureau of Mines; Bull. 70, Mineral Tech. 2, Wash. Gov. Print. Off. pp. 1-101, 1913.

An abstract of part of the report of the Radium Institute of London:

"Statements from another source indicate that 80 per cent. of cases of arthritis treated with comparatively strong doses of the radium emanation dissolved in water are either cured or greatly benefited. The dosage in such cases is as follows: The radium emanation obtained in one week from one gram of radium bromide in solution is dissolved in 17 liters of water. One hundred c.c. of this solution is taken twice a week by the patient. This means that 1 gram of radium bromide can be used for treating about 170 patients at one time. The exploitation of radium in medicine has been carried even further. Inhalers, which usually involve the inhaling of oxygen also, and 'bath salts', containing small

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quantities of radium, are to increase; their value has by no means been thoroughly demonstrated."

Thorium X in Internal Disease.

O. Meseth. Münch. med. W'chenschr. 602, no. 38: 2105-2110, Sept. 23, 1913.

Thorium treatment in:

Sciatica—male, age 42; right atrophy; pronounced Laseque; thorium X 50-150 e. s. u. given as a drink; drank total of 2300 e. s. u.; at first general improvement; then recurrence of pain; 3 eucaine injection; relief only temporary; 7 injections of 100-300 e. s. u. thorium X; patient now feels pain only occasionally.

Sciatica—male, left sciatica since 3 months; salicylate and hot air baths bring relief only when resting; eucaine injection brings 2 days relief; thorium X ordered as a drink; 16 drinks at 50-100 e. s. u. combined with 2 more eucaine injections; treatment brought complete relief.

Articular rheumatism—female; in 1910 articular rheumatism; frequent pains in ankle joints since that time; recently also pains in wrists; both ankles, left wrist and carpometacarpal joints swollen and tender to touch; walking impossible; thorium X injections, twice 200, twice 300 and 100 e. s. u.; pain rapidly decreased; result of treatment, no swelling, no pain, joints freely movable, walking normal.

Secondary anemia—no sex, no age given, ulcerated stomach with intense pain and periodic bleeding; thorium treatment, 17 injections of 50-200 e. s. u.; after the acute stomach symptoms subsided, the erythrocytes increased from 2,500,000 to 4,500,000; hemoglobin remained at 55%; general health good.

SECTION II
RADIUM IN SURGERY

United States Radium Corporation
New York

SECTION II

RADIUM IN SURGERY

Radium in Surgery.

W. S. Schley, New York M. J., 114: 573, Nov. 16, 1921.

Observation of several thousand cases during sixteen years' experience results in the conclusion that radium is applicable as an adjuvant measure to surgical procedure or as an ameliorative of surgical conditions. Radium has a good effect on the capillary nevus, and brilliant results have been secured in the larger hemangiomas, some of which had been operated upon repeatedly without success. Keloid has been removed leaving a flexible, soft skin and linear cicatrix; warts and keratoses vanish after one treatment, as do intractable patches of eczema and psoriasis. Inoperable carcinomas of the mouth, tongue, pharynx and esophagus usually show an initial retrogression but are little affected after this has passed, and progress unfavorably, although life is often prolonged and pain relieved. Cases of apparent cure have been reported at the end of two years. Internal malignancies have not yet been conquered but merely retarded. These cases can be injured severely by improper treatment. In one case of carcinoma of the urethra and contiguous part of the bladder, the bleeding has stopped at the end of a year's treatment, the tumefaction is half its former size and the health of patient is apparently unimpaired. Inoperable cancer of the uterus is at times wonderfully benefited and occasionally cured. Carcinoma of the vagina does not improve. Fibroid uterus reacts astonishingly. A case of enormous spleen of the Gaucher type has been most successfully treated with radium. The size has been greatly reduced, the hemoglobin of the patient raised from 39 to 76% and her weight from 132 to 155 pounds. After 4 treatments she is still improving and working hard daily. The enlarged thymus gland in infancy and childhood has been successfully treated, and radium exposures have even been given as an emergency measure in acute suffocation. Radiographs have shown disappearance of the tumor in these cases and relief is often noticeable in twenty-four hours. Lymphosarcoma of the glandular system and mediastinum are showing two to four year cures. Inoperable conditions of the breast are arrested and pain relieved.

Radium, therefore, affords a distinct adjunct to the surgery of both malignancy and benignity, the technic of its employment having everything to do with its success. Correct dosage is the one fundamental principle of radium therapy and can be learned only by long experience. Undertreatment may be as productive of harm as overtreatment. As to its postoperative value in malignancies, there can be no doubt. Pre-operative treatment over the many lines of lymphatic extension both within and without the operative field will increase the number of surgical cures. In the use of radium the chief factors to be considered are: the different reactions established in different tissues, length of exposure, quantity of radium salt or emanation, kind and quantity of filtration or screening, character of growth and location, form of treatment—surface or implantation and from what direction, frequency and

size of doses. While radium is at present most useful in the epiblastic surface tumors, its application is being constantly extended. The development of radium treatment will rest with the clinician rather than with the laboratory worker and radiologist, unless a closer relationship can be established between the pathologist and the surgeon than has formerly existed.

Radium: Its Therapeutic Uses in Surgery.

Arnold Schwyzer, Minnesota Med., 4: 533, Sept., 1921.

The uterus is a favorable area for the treatment of tumors. The writer has observed the cessation of profuse menorrhagia in uterine fibroid and an almost complete disappearance of the fibroid itself, which was the size of a three months pregnancy, after a twenty-four hours' vaginal application of 50 mg. of radium element. He has not used radium in fibroids larger than a uterus 4 months pregnant. In all cases of simple uterine bleeding, menorrhagic or metrorrhagic, a diagnostic curettage should be made. Intra-uterine application of radium can be used at once, or it may be introduced vaginally. In intra-uterine application, nausea may be severe, a watery discharge may follow the treatment for months, and if even very slight and quite old inflammatory residues exist in the adnexa, unpleasant results may appear. Badly advanced cervix carcinomas with involvement of the vagina forming foul ulcerated craters quite commonly improve amazingly. If a return of the growth occurs, there comes a time when radium has no further staying effect; the tumor then runs wild. Two cases of carcinoma of the upper jaw that had been operated on elsewhere came to the writer three years ago. He first resected atypically extensively, then applied the hot soldering iron to the limit of permissibility; 5,000 mg. hours of radium were given within a week starting a week or so after the operation. Both patients are still well. In one case of carcinoma of the base of the tongue, the tumor was removed by a lateral submandibular incision; radium was placed into the bottom of the remainder of the tongue, and close watch kept for sudden edema of the larynx. Later the wound gradually opened somewhat, and now, at the end of a year, the writer has put a pedunculated flap over the opening. In another case, in which a tumor of the size of a tangerine filled the back part of the mouth and larynx, plugging the entrance to the larynx, the large mass was removed from the posterior wall of the pharynx, and 50 mg. of radium inserted and packed tightly. The patient has had no recurrence for two years. In 3 cases operated on six years ago, what seemed clinically and microscopically to be a struma proliferans of Langhans (a form of adenocarcinoma of moderate malignancy) was extensively excised and strongly treated with radium, and has given no further trouble. In carcinoma of the breast, the writer gives pre-operative x-ray treatment for two days in order to stun the cells enough to make implantation less likely. The atrophic forms, which so often come late upon the operating table, are definitely benefited by radium or x-ray.

Radium Therapy as an Adjunct to Surgery in Inoperable Malignancy.

William D. James and Albert W. James, South. M. and S., 83: 218, May, 1921.

Whether or not inoperable carcinoma of the uterus, which has been treated by radium, should be operated upon after all the gross signs have cleared up, is the question discussed. In 15 such cases reported by the authors, it was found that radium therapy had checked the progress of the disease to such an extent that the clinical signs, both local and general, abated until vaginal examinations failed to reveal further manifestations of the malignant condition.

In these cases the radium was inserted within the birth canal in direct contact with the diseased areas. Particular attention was paid to thorough exposure of the cervix, and the radium was left in place for a primary dosage of 400 to 600 mg. hours. The radium was carefully screened and the rays filtered through the containing glass capsules, an aluminum or brass capsule, and one or more sheets of lead-foil of 1 mm. thickness, the whole radium body with the screens and filtering substances being rapped in rubber tissue and further filtered in this way. The amount of radium used was from 35 to 60 mg. The second irradiation was given within ten days or two weeks, and subsequent treatments at two-week intervals, then at three, then at four-week intervals, over a period of several months, or as long as the condition seemed to require. During the treatment, patient's general health was carefully looked after; tonics of iron and arsenic were prescribed, together with nutritious diet. In connection with the irradiation at the site of disease, a thorough and systematic exposure of the patient's body to the x-rays was made. The results show that after four radium exposures the hemorrhage was checked or had disappeared in practically all cases. General upbuilding of body weight and vitality followed. Several patients who were bed-ridden were able, after two months of treatment, to attend to light household duties and to be up and about. In all cases the vaginal discharge became somewhat lessened after the second treatment and usually stopped entirely after the fourth application. The blood-picture, which had been that of pronounced secondary anemia, rapidly improved. Large, ulcerated areas along the vaginal walls and extending up into the fornices healed with a minimum of cicatricial tissue formation. Nodular and cauliflower-like growths on the cervix disappeared and the healing process took place so smoothly that often it was difficult to discern where the growth had been. All patients were instructed to report for reexamination every three months after discharge from treatment, or earlier if symptoms developed.

In many of these cases, the clinical manifestations having so completely disappeared that the authors are "tempted to call the results cures," the question is raised whether operation should be performed while the patients are apparently good operative risks. No opinion is advanced by the authors except that they find in the literature that recurrences in such cases prove refractory to further irradiation.

In the cases which proved hopeless, among the authors' patients, radium treatment was continued for about a year, some of them having received over 5,000 mg.-hours of irradiation, and the relief was such that, even when in the throes of a rapidly developing fatal cachexia,

the patients were comfortable and were not compelled to resort to opiates.

Uses of Radium in Surgery.

E. E. Bamford, J. Iowa State M. S., 11: 167, May, 1921.

It is not clearly understood what properties in radium rays cause the changes in cancer cells. If this treatment is to surpass previous methods it will be due to its effect on metastasis, since it is at this point that surgery fails. It is at present believed that the hard beta and gamma rays will penetrate tissues about 5 cm. with destructive effects on the cancer cells, and that the normal tissue-cell will withstand a radiation which destroys the malignant cells, the rays acting locally upon them. If there is a constitutional factor in the causation of cancer, then radium acting locally cannot be regarded as a cure.

An authority who has studied pelvic metastases states that in from 40 to 50% of operative cases of cervical and uterine cancer, metastases are found in the pelvic nodes, which would seem to indicate that even Wertheim's operation gives little assurance that all outlying cells are reached. Here radium offers new hope. Radium is preferable to surgery in that it does not require major or cutting operations and does not disfigure. It should be used if possible in inoperable cases, for treating early cancerous lesions of the cervix uteri, rectum, mouth, tongue, throat and skin; many give radium first choice. Attention is called to the existence of radium toxemia, noticeable in most cases. When this reaction is considerable a temporary discontinuance of treatment is required.

The Duty of Every Surgeon to Employ Radium.

E. O'N. Kane, Internat. J. Surg., 32: 163, 1919.

This author's belief is that, just as much as a surgeon finds it to his advantage to employ a full line of surgical instruments, a capable anesthetist and the x-rays, it would be equally to his advantage to use radium. Surgery is not so narrow a profession as to confine the operator to the limited services of a skillfully handled knife. The patient entrusts himself to the surgeon expecting him to save or prolong life and alleviate suffering. If he does not include radium in his outfit, he cannot, in many cases, fulfill this trust. While all operators may not be in a position, personally, to own an adequate supply of radium for their patient's needs, it ought to be possible for them to rent what they require. Every hospital should, as a matter of essential importance, secure a sufficient amount, if it has not such already, and the surgeons and physicians connected with the institution should make it their business to see that it continually increases its numbers of milligrams with the same assiduity as in the acquisition of charity beds, or any other of its life-saving agencies.

Except in some pressing emergency no surgeon would be excused for undertaking a major operation without providing himself with the full surgical paraphernalia. Ignorance of what was necessary for the undertaking would be no excuse for vital omissions; nor might the plea of poverty relieve from censure, for radium, being no longer a mys-

terious element of rarity, anyone can avail himself of its advantages, either through a hospital in charity cases, or through some organization which loans it out to its members.

Unquestionably, cancers can be, and undoubtedly are cured by the knife alone, provided the operation is done early and includes a large area of healthy tissue. Unfortunately most cases come too late, and the work of the operator is largely palliative, often seeming to hasten death by producing metastases due to the laying open of lymphatic channels and vessels for rapid constitutional invasion. Every experienced operator knows how fruitless late operation is, and longs for the day when a specific cure will be discovered. Radium is not an infallible specific; it is not an absolutely reliable "cancer cure." It has its disadvantages, and the failures after its employment are too many to be ignored by those most sanguine in its praises.

It has, however, cured so large a proportion of cases as to give it first place in the management of malignancies. It can and does do what no other means as yet at our disposal (save x-rays to a much lesser extent) render possible. Its emanations penetrate not only into and through all visible, tangible portions of the diseased tissue, but beyond into those where infection is not plainly demonstrable, though actually present. But even if radium does not effect a permanent cure (in many cases it does), if only a clinical cure of the cancer is obtained, if only for a year or so in hopeless, advanced cases, this is enough to demand its employment. These patients should be given the advantage of what little life is left to them in comparative comfort with the hope of a cure to cheer them. Should the case have passed beyond even a clinical cure, the use of radium tends to arrest hemorrhage, suppress offensive odors and relieve much of the pain.

The author does not mean to imply that he advocates abandonment of the knife. But he insists that no malignancy should be treated without radium either alone or associated with x-rays, whether operated upon or not. Its use before the operation tends to limit those dangers attendant upon surgical manipulation whereby lymphatic, circulatory and metastatic extensions are produced. After operation a thorough raying of all contiguous and suspicious areas has a wonderful prophylactic influence against recurrence and should never be omitted. This influence is, of course, relative and depends largely on the amount of radium used. Skill and judgment in its application, among other things, lend much to its success. The knife, thermal therapy, and any other means at command are justifiably employed in this awful disease—cancer. Yet, singly, or altogether, none of them yields as satisfactory effects as radium.

Though radium therapy has received some hard knocks in its early days, due to improper and inexperienced use; though it has been discredited because quacks have used other means, pretending they were radium; though personal jealousy on the part of those surgeons who were not fortunate enough to possess radium has done much to injure its reputation; despite all this, radium stands out as a most valuable asset to the surgeon of to-day.

Radium, Its Present Status as Surgery's Adjunct.

C. E. Field, Med. Rec., 95:1081, 1919.

The author confines this paper to a discussion on the treatment of malignant tumors. From both a practical and clinical viewpoint the action of radium as an aid to surgery may be classified into four divisions:

- (1) As a substitute for surgery.
- (2) Before surgical proceedings as a preparatory method.
- (3) Combined with surgical procedures.
- (4) Postoperative or prophylactic.

In the first group are all lesions which are inoperable or inoperable by any surgical means of enucleation. In all operable malignant conditions or when the growth is inoperable, radium is indicated. Radium is indicated when surgery is impracticable or impossible, because of inaccessibility of the growth, its extent, its special nature, the malcondition of the patient because of the prolonged duration of the disease, or in cases where excessive mutilation or impairment of normal functions would follow a proper removal.

Malignancy involving not only the uterus and adnexa, but the adjoining lymphatics and neighboring structures, offers no hope of cure by any ordinary surgical method of removal. Epitheliomata of the ear or eyelid, of the entire lip or of the nose are presumably inoperable for cosmetic as well as physiological reasons. Cancers of the tongue are now regarded by most surgeons as inoperable, and radium becomes the remedy of election.

There is a class of cases where surgery seems to hasten the death of the victim, because operation seems to stimulate the growth recurrence of the neoplasm. Melanosarcoma is such an example. The only hope of cure in these patients is the use of radium.

There are three specific diseases where the reports of relief by the use of radium are so definite and certain and are confirmed by so many cases, as well as by the experiences of such a number of observers of unquestioned skill and veracity, that radium is, from the first, the method of choice. The diseases referred to are lymphosarcoma, tuberculous glands, and fibroids of the uterus.

In the second class, radium is advised as a preparatory treatment; here opinions are divided. Many operators advocate strongly the avoidance of any interference with the affected tissue by radium application before operation, contending that such treatment destroys much of the recuperative quality of the neighboring structures and lessens the local vitality, and also that it interferes with the absorbing power of the tissues and affects adversely the general condition of the patient.

On the other hand, many observers assert that inoperable cancer may become operable by proper radiumization. Nogier, of Lyons, advises repeated radiation of the lymphatics of the growth at the circumference of the tumor. He proposes destroying the malignant cells and blocking off the communicating and distributing vessels. This prevents the carrying of those cells away to form metastases. Such radiation is to be begun at the peripheral end of the lymphatics. The author heartily sanctions this pre-operative treatment.

"In the third group are the cases in which radium application and surgery are combined. This divides itself naturally into two classes.

First, those cases in which it is impossible to remove all the cancer tissue and it is desirous to employ radium in combination with surgery to obtain the effect during operation and after the time of the operation. To do this, immediately on finishing the excision an adequate amount of radium is packed into the wound cavity before closing. This is allowed to remain the required period of time, after which the sutures are drawn in to bring the wound together. Second, where a large cancer mass is to be removed in order to shorten the time of treatment with radiumization, and cases where the operation is simply to avoid the necessity of absorbing a large amount of broken down cancer cells and toxins which otherwise must necessarily be carried off by the physiological processes of the body. In this subdivision the operation is performed in order to facilitate the use and effect of the radium. Surgery is employed here to assist the action of radium. No operation for a neoplasm is satisfactory which does not remove the most widely spread cancer tissue. In sarcomata, especially, is a wide sweep of the excision line indicated, and the operator is never quite sure that it is wide enough. Radium, at the time of excision, would add to the probability of a more thorough and extensive destruction of the suspected tissue without dangerous mutilation. Theoretically this is an argument for the use of radium in all operations, for in no case can it be certain that the knife has extirpated the furthest cancer nests. In the removal of the cervical carcinoma, for instance, infiltration into the broad ligaments and vagina seems to call for radium at the time of the operation and several hours thereafter.

"In the fourth group we have postoperative prophylaxis. Of the necessity and the values of this method there can be no doubt and yet many well known gynecologists, as well as skilful and experienced general surgeons, still maintain a lukewarm attitude toward radium. There have been so many sensational claims made for radium in its earlier day that we may excuse their skepticism. During the past two years, however, many of the foremost surgeons have accepted post-operative radiation without criticism. In fact, it is becoming a routine measure with some gynecologists.

"Repeatedly, in the experience of the writer, under carefully carried out radiations, malignant recurrences have disappeared. Nodules have been destroyed and ulcerations checked. Hemorrhages have ceased and, perhaps because of the mental benefits produced, the general condition has greatly improved and the patient has been clinically restored to health. If this is true, why not systematically make one or more prophylactic applications of radium in every case to the involved area at the location from which the cancer mass was totally removed as well as to the surrounding tissues where recurrences might be assumed to present?

"There is always something to be said about those cases where operation is impossible or where recurrence is rapid and overwhelming in its return. Such victims of malignant disease are not infrequent, and for them there is no other chance, no other resource, except that which may be granted by vigorous, massive and long-continued doses of radium. It holds out for them at least some relief of pain, hemorrhage, odor, discharge, and other inconveniences or distress, and if applied with confidence and belief in its efficiency, in adequate amounts,

by an expert of acknowledged skill, it may help them both physically and mentally and restore, if only temporarily, the joy of life and hope. We have not done all for such a patient unless this final means of healing is tried."

Radium Versus Surgery—Some Comparisons.

C. W. Hanford, Interstate M. J., 24: 930, 1917.

In the treatment of malignancy by surgery the preservation of healthy tissue in the process of eliminating the lawless cancer cells has not in the past been considered. The one aim has been to cut deep enough to include all cancer cell nests.

As a result of this radicalism, when the lip, nose, cheek, or immediate neighborhood of the eye is involved, the resulting scar is very unsightly, and, while the patient is very glad to be rid of the malignant growth, even if the mouth or eyelid should be drawn out of shape, yet it would be much more gratifying to all concerned if the malignancy could be obliterated without disturbing the cosmetic effect, except to a very slight degree.

The author explains, from photographs and drawings, two cases of epitheliomas of the lip, showing the amount of tissue the surgeon would have to remove to totally destroy the growth, whereas the radium treatment was just as effective, and the cosmetic result remained good.

Relations of Radium to Surgery.

D. T. Quigley, Med. Herald, 34: 5, 1915.

The author greatly praises the results obtained by the radium treatment, when it is handled by a person properly trained and experienced in its use. But a great deal of trouble and injury can be caused by putting it into the hands of the unskilled.

The effect of radium is not the same as the x-ray. It has several hundred times more penetration than the x-ray, the burns heal quickly and with very little pain, and it has been found that the best treatment for x-ray burns, x-ray eczema, and x-ray cancer is the application of radium.

Mistakes have been made with radium by using too large a quantity. If an unreasonably large quantity be used and the exposure be too long, the patient will be overwhelmed with broken-down cells and the resulting auto-intoxication may hasten the death of the patient. Radium is a good thing, used in *reasonable* dosage.

Two of the leading clinics of Europe have substituted radium for the knife in the treatment of cancer, but in most of the European clinics and in the author's own work it has been reserved for inoperable cases and post-operative treatment. In most inoperable cases the results of the treatment are very gratifying, and beyond any other treatment. The first thing noticed is the disappearance of pain, then drying up and disappearance of discharges and bleeding, then shriveling up of the tumor mass.

Radium is indicated in every case of cancer: in the operable cases as a post-operative treatment to prevent recurrence, and in the inoper-

able cases to relieve distressing symptoms, prolong life, and as a possible cure.

Schauta reports eleven clinical cures in twenty-two inoperable cases of cancer of the uterus, Wertheim six out of eighteen, others in proportion. Besides, a large number of inoperable cases have been brought into the operable class by the retrogression brought about by radium. No case of cancer or sarcoma should be considered hopeless unless radium has been tried, and in no case of cancer should radium treatment be neglected if it is possible for the patient to get the treatment. Radium should not supplant surgery in any operable case, but should be used in conjunction with surgery to get the best results. In skin cancer about the face, radium is to be preferred to the knife, as hardly any scar is left, and the results are at least equal to surgery. In benign tumors the action of the radium is well brought out by Kelly's statement that he does not operate any more for fibroma or myoma except in the small per cent of cases where satisfactory retrogression of the tumor cannot be brought about by the use of radium.

In keloid the action of radium is practically specific as it is also in lupus and tubercular glands of the neck.

SECTION III A
GYNECOLOGY

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GYNECOLOGY

Radium Therapeutic Drainage of the True Pelvis.

Frans Daels, Gynec. et obst., 4: 459, Paris, Nov., 1921.

One of the fundamental principles adopted by the author for the radium treatment of tumors is to irradiate them at their base of insertion and of lymphatic propagation. Three tubes of radium placed one in the uterus, vagina, rectum or bladder, and the others on both sides of the true pelvis, can sterilize tumors in a zone even greater than the latter. In order to place radium tubes alongside of the lymphatic paths and tumors of the pelvis, they are inserted in drains which can be easily slipped under the peritoneum and vessels. There are various paths of drainage, according to the location of the tumor and lymphatics which are to be irradiated. After trying his method on a few patients the author has applied it systematically to 3 cases of carcinomatous relapse after hysterectomy, 11 cases which were deemed inoperable on account of the extension of the tumor to the parametrium, vagina or bladder, and in 2 cases of cancer of the cervix where vaginal hysterectomy was also performed. No operative complications were noted. One patient died of obstruction due to an adhesion of the intestine to the scar of a vaginal hysterectomy. Another had a chill and fever on the fifth day and died on the sixth from hemorrhage. In several patients the course of the drains became infected. Three had transitory symptoms of neuritis. In one a vesical fistula occurred which healed spontaneously. Two patients had rectal ulcers, but in each a tube of radium had been placed in the rectum for several hours. Finally, in a 60 year old woman complete atony of the tissues was noted.

Definite clinical results are obtained by radium. Extensive ulcerations have healed and cachectic patients have resumed an active life. The first patients treated, who were given up as hopeless by surgeons, still appear to be cured one year after the treatment. The author considers the results encouraging but nothing more. He proceeds at the present time as follows: Nonoperable cases; curettage and bilateral drainage in one sitting. Operable cases: vaginal hysterectomy and bilateral drainage in one sitting. Vaginal irradiation after a few days.

The Present Position of Radium in the Study and Treatment of Uterine Cancer.

Wm. S. Stone, Surg., Gynec. & Obst., vol. 32, 509, June, 1921.

"Radium, in all recurrences, although less effective than in primary lesions, produces immeasurably better results than operation, provided they are not too far advanced and are not so closely related to the bladder or rectum that to cause their regression will produce fistulae or severe functional disorders.

"The discussion of the use of radium in primary uterine cancer has largely centered about the term operability in defining its field of

applicability. From a practicable standpoint, the use of this term for the classification of cases gives an erroneous idea of the importance of the operation. In the hands of a few highly trained pelvic surgeons, at the expense of a high primary mortality and numerous complications and sequelae, a definite percentage of permanent cures has been obtained, compared with which, because of the factor of time, our present estimate of the value of radium must be largely measured by the primary results. Operation, therefore, for the treatment of uterine cancer continues to be performed to an unjustifiable extent, producing unnecessary suffering and mortality, and bringing discredit to both operation and all other sincere efforts to cure the disease. In other words, the growth when it reaches the hands of a competent diagnostician has extended, with few exceptions, to such an extent that palliation is the only justifiable conception upon which to base the treatment. For all cases, therefore, of primary uterine cancer, with few exceptions, radium should be regarded as the method of choice. Of 34 cases, representing about 25 per cent. of 139 patients who had applied to the Memorial Hospital for treatment within 3 months after the beginning of symptoms, a primary and complete regression was obtained in 16, or 47 per cent., and a partial but substantial regression in all of the remainder. Of the 16 cases in which the regression was complete, the growth was limited apparently to the uterine tissues in three, and in the other 13, the extrauterine involvement was not extensive. Of another 34 cases who had applied for treatment within 4 to 6 months after the beginning of symptoms, the disease was considerably more advanced. There were three, however, in which the growth was apparently limited to the uterine tissues, and in all a complete regression was obtained. In 18, or over 50 per cent., although the involvement of the extrauterine tissues was considerable and the regression could not be regarded as complete in any, the disappearance of symptoms and restoration of normal health was evidence of the value of the treatment. An improvement followed the treatment in the majority of the others. There was no improvement in a few, and in two instances the patients were, perhaps, made worse. In forming an estimate of the permanency of the primary results, the action of radium upon the tissues extends over such long periods, 6 or more months, that it is idle for the purpose of statistical study to define the condition of the case until at least one year after treatment. Without the knowledge also gained by operation it is difficult to define results as measured by the extent of the original lesion. There are numerous cases in these series of cases who are apparently well 2 or more years after the treatment has been made.

"The question regarding the use of radium in the so-called border-land cases has become a subject of frequent discussion, and it is in this field, the writer believes, that radium has demonstrated its remarkable value. With a properly adjusted dose and form of application, radium may be expected regularly to destroy all intrauterine tissue, and it is capable of destroying extrauterine tumor tissue to a depth fully within the limits of what is generally regarded as operable with more certainty than operation. We know that cases judged to be outside the limit of operability are frequently made to appear to be well within such limits after the use of radium and the limiting of the field of operability by surgeons who are only using a comparatively small amount of the

radium salt gives ample confirmation to this opinion. The question of operating in this type of case after radium has produced an apparent regression must await the reports of final results, but the histological changes that radium produces in the extrauterine tissues show that such a procedure is probably erroneous. If radium has caused a complete destruction of tumor tissue, operation, of course, is unnecessary. . . .

"Lastly, a strong plea is made to avoid treatment of primary cases that are too far advanced. Unless this warning is generally and promptly heeded, much unnecessary suffering will continue to result, and radium will soon be as discredited as is the operation, in the eyes of the public. There are numerous primary cases in which the general health appears to be little, if at all, affected, but in which the local lesion has advanced so far that all of the normal anatomical relations of the pelvic structures are obliterated. To treat such cases will result only in the premature production of the terminal stage of the disease."

Radium in Gynecology.

Shields Abernathy, J. Tenn. State M. Assn., 14: 91, July, 1921.

Unless the situation is changed by future studies in endocrinology, radium will doubtless continue to be the main reliance in the treatment of non-malignant uterine bleeding. Uniform success seems to be the experience of all workers, in reports of these cases. As a rule one or two small doses of radium not exceeding 600 mg. hours, restores the normal menstrual life. A number of such patients are reported to have borne children after the treatment. Care should be taken to exclude malignancy. Pain lateral to the uterus usually indicates an inflammatory process which radium lights up, with disastrous results.

Fibroid tumors of the uterus, where the growth is small, the condition uncomplicated, and where surgery is contraindicated in the more severe and complicated cases, are most safely and easily treated with radium.

A Conservative Estimate of Radium in Gynecologic Practice.

Chester Ford Duryea, Long Island M. J., 15: 243, July, 1921.

Too zealous radiation may cause so much destruction of tissue that the patient is overwhelmed by the toxin thus produced and a fatal termination is thus precipitated. To-day radium therapy can only be properly instituted when it combines the support of the pathologist, the biochemist, the physicist and the clinician.

In the light of our present understanding, every inoperable uterine carcinoma case should be classed as a radium case and all carcinomas of the cervix should be given radium as the method of election. A conservative estimate of cervix cases shows clinical cures under radium in about 30% of cases.

In idiopathic uterine hemorrhage radium under proper technic gives results comparable with the best findings following any other radical method of treatment. Practically all cases of this type respond to proper radium treatment. Radium by no means displaces surgery in the treatment of myomas, but in selected cases it must be the method

of choice. We must always remember that the use of radium in fibroids causes no primary mortality. In chronic endometritis radium usually produces lasting relief. The dosage here calls for the use of a 50 mg. tube, in a screen of $\frac{1}{2}$ mm. gold, applied for a period of from four to eight hours, and repeated in from four to eight weeks if required. While Duryea hesitates to advocate radium for excessive hemorrhage in young women under 30 years of age, he says that where hemorrhage is of the dangerously excessive type, one has no choice. Radium is the best agent at our command. In 192 essential uterine hemorrhage cases treated at the Radium Institute during the past four years, over 90% have responded with entire satisfaction. Radiation over the ovaries will at times control uterine hemorrhage almost as effectively as the direct intrauterine application.

Observations on the Technique and Indications of Radium-Therapy in Uterine Carcinoma.

H. Schmitz, Surg., Gynec. & Obst., 31: 177, 1920.

A radium capsule within the cervical canal will disperse the rays evenly through the pelvic cavity. The rays must penetrate 6 cm. of tissue all around with such an intensity at the periphery that carcinoma cells at this distance are destroyed. To keep the bladder and rectum from too close proximity, they should *always* be emptied completely just before beginning the treatment and kept empty during the treatment.

Twenty-five mg. of the element in the form of an insoluble sulphate is packed into a glass cylinder, inserted in a silver capsule (wall 0.5 mm., length 1.75 cm.). Two such capsules are placed in a brass filter which has a wall thickness of 0.7 mm. This absorbs the beta radiation. A pure, black rubber tubing covers the metal and absorbs the Sagnac rays.

The sensibility of carcinoma tissue is estimated to be one-half greater than normal. Treatment is not repeated unless recurrence takes place. Adequate drainage of the uterine cavity must always be provided. If pyometra develops, insert a soft rubber T drain into the uterine cavity after each removal of the radium carrier and for several weeks after discontinuance of the treatment, until the secretion is negligible.

If local healing is obtained, the patient should not be subjected to an operation.

Radium Treatment of Uterine Hemorrhage.

T. C. Kennedy and W. H. Kennedy, Med. Rec., Vol. 97: 141, 1920.

In the treatment of uterine hemorrhage, the gamma rays only are used, the other rays being filtered by brass, silver, gold, platinum or other metals.

The cases treated are: (1) those in whom no gross pathological conditions can be found, and (2) those presenting a distinct pathological condition, such as fibroma or carcinoma. In the latter case, the bleeding should be considered only with the malignancy.

"Technique: The patient is given the routine hospital preparation

for a vaginal operation. Gas is given and the cervix is dilated. The radium is in an hermetically sealed glass tube and this is placed in a silver tube .5 mm. in thickness; this, in turn, is put in a rubber tube 5 mm. thick. The radium prepared in this way is introduced into the uterus and allowed to remain for from twelve to twenty-four hours.

"At the end of this period, the radium is removed, the patient is permitted to remain home with instructions to keep off her feet for a few days and to report her condition at the end of six weeks. As a rule, we do not repeat the treatment under three months, but in our experience only a very few cases have required a second treatment.

"Patients during the child-bearing period are given a smaller dose, as it is desirable to preserve the menstrual function. Patients at or beyond the menopause are given an application of from 600 to 900 radium hours, and this will usually be sufficient to produce a permanent menopause. In the greater number of our cases there has been at least one menstrual period after the administration of radium. It is well known that the effect of radium is manifested slowly."

Radium Treatment in 600 Cases of Menorrhagia.

L. J. Stacy, Am. J. Roentg., Vol. 7: 379, 1920.

While surgery is still the method of choice for young women who have definite fibroids causing menorrhagia, and those with a suspected carcinoma of the fundus, Roentgen rays and radium are successful therapeutic agents in carefully selected cases and in women over thirty-five.

"Of the series of 600 patients with menorrhagia with or without uterine myomas treated with radium at the Clinic (Mayo) from July, 1915, to January, 1920, 438 have been head from. Sixty-nine of these occurred in three patients; two were women of twenty-two who had been given two tubes of 25 mg. radium for four hours each; the other, aged twenty-six, had been given 25 mg. for nine hours. One patient, aged thirty-one, with small multiple fibroids, was given two 25 mg. tubes for six hours and the periods became regular and normal; three years later she gave birth to a normally developed full-term dead child.

"Menstruation again became profuse two months after confinement and four months later, 350 mg. hours were given. Two days after treatment, the patient developed a rapid pulse and evidence of shock, without rise in temperature or evidence of peritonitis, and died twelve days later. This is the only death in our series and has not been satisfactorily explained.

"One woman gave birth to a premature dead fetus after receiving 23 mg. radium for ten hours, and another gave birth to a premature deformed fetus after receiving 50 mg. for six hours. One woman of thirty-seven, who had 250 mg. hours, had two miscarriages at three and six months. One woman of twenty-five, after 25 mg. for ten hours, is now six months pregnant. One woman, aged thirty, who had had 25 mg. for ten hours, was questionably pregnant at the time she reported.

"In the treatment of menorrhagia in patients more than thirty-five who have a fibrous uterus or a small myoma, and in younger patients in whom myomectomy or hysterotomy is not indicated or in whom cur-

rettement has not controlled the menorrhagia, radium is a very satisfactory therapeutic agent.

"Radium should not be used, however, for patients who give a clinical history or present physical signs of pelvic infection or of pyometritis, nor for those who complain of chronic pelvic pain, since the application of radium may light up a quiescent infection. We have had three cases in which operation was done because of the infection after the application of radium, in one in five weeks, in one in six weeks, and in one in three months.

"In our series of 600 cases were 122 women under thirty-five; nineteen were twenty-five or under. Eighty-nine were heard from. The average dose of radium given to these patients was 293 mg. hours. Menorrhagia was controlled by one treatment in 55.6 per cent.; a second treatment was necessary to control the menstruation in seventeen cases. In twenty-five, the periods were reported normal in amount; in eleven irregular and scant, and in six, menstruation ceased; three of these patients, aged twenty-eight, thirty and thirty-four, respectively, had 300 mg. hours. Hysterectomy was performed later in six patients; one patient, aged thirty-two, was operated on eight months after receiving 400 mg. radium hours without improvement; one, aged thirty, was operated on one year after receiving 375 mg. hours treatment without improvement; one, aged twenty-eight, was operated on after one year because of pelvic pain, although the profuse flow had not returned; one, aged thirty-one, was operated on after receiving 200 mg. hours treatment without improvement, and one, aged twenty-seven (a case of hemophilia and myoma) was given 300 mg. hours treatment, then transfused and given 400 mg. hours. Menstrual periods were regular for eight months, followed by a continuous flowing for five weeks, when the hysterectomy was performed.

"One girl of sixteen was given 100 mg. hours one year after a curettement with only temporary improvement; the flowing was more or less continuous, and two years and nine months after the radium treatment, a hysterectomy was performed; adenocarcinoma of the fundus was found. Abdominal myomectomy was performed in seven patients who received only temporary benefit following the radium treatment; two of these had had radium treatment a second time.

"We attempt to give the women under thirty-five enough radium to control the symptoms, but not enough to stop menstruation, and it is difficult to judge the amount necessary in each case. It is better to give a small dose, however, and if there is a recurrence of the profuse flow, repeat the dose in three, four or six months, than to give enough at the first treatment to stop menstruation.

". . . There were 478 patients more than thirty-five, and of this number 349 have been heard from. In eighty-one (23.2 per cent.) of these, the examination showed the uterus to be 'fibrous' or not 'large.' In 220 cases, the uterus was graded three on a scale of 1, 2, 3, 4 of the fibroids graded 1, and in twenty-nine the fibroids were graded 2 or 3. Thus in the large percentage of cases the treatment was confined to the smaller tumors and the large doses given by many physicians were not used.

"In the series of 349 patients it was necessary to repeat the treatment in sixty-four, and an operation was done later in twenty. Only

four of the twenty were given a second radium treatment, and two had operations elsewhere too soon after treatment to obtain the effect of the radium. Menstruation became regular and normal in thirty-nine (11.17 per cent.).

"Of the patients more than forty, 263 were heard from; in 185 (70.35 per cent.) of these menstruation had ceased. Only fourteen of this group were given two treatments; four were given the two treatments close together; the other ten received a second treatment after from one month to one year.

"In the large percentage of those cases in which menstruation ceased, there were two periods following the treatments before the cessation. Improvement in general health was reported in 231 cases, and gain in weight in 157 cases. No improvement was reported in sixty-eight."

The technique is the same as has been used for several years, differing only from that published earlier in that either emanation or radium element is used, and in slightly larger doses for older persons, but usually not more than 700 mg. hours. If that is insufficient, the treatment is repeated in a few weeks or months.

The Therapeutic Use of Radium in Gynecology.

J. G. Clark, Surg., Gynec. & Obst., Vol. 26: 619, 1918.

For the relief of symptoms and cure of cases of chronic metritis and small myoma uteri radium may be a worthy competitor of myomectomy, or hysterectomy, if certain conditions are fulfilled. Briefly, it must effectively cure, must be attended by as small a risk or by even fewer hazards than accompany a well executed operation, and must be unattended by immediate or remote complications. The cure must be permanent.

"We use radium only in very light dosage in the treatment of young women in whom a tumor is not palpable, but who are suffering from a depleting flow at the periods. In young women in whom a myomectomy is possible, we advise operation, for in these cases the uterus may be restored to normal, and the ovaries are preserved. Briefly summarized, we may say that we apply radium in the following groups of cases:

"In large dosage, 50 milligrams for twenty-four hours, in women suffering with myopathic hemorrhage or menorrhagia from myoma, in women over forty years of age. In such cases, we expect to bring on the menopause, and in practically all, we are successful.

"In smaller dosage, 25 to 50 milligrams for from three to eight hours in young women with excessive menses incident to myopathic changes, in very small myomata, in polypoid endometritis and in those cases of irregular and profuse bleeding attributed to excessive functional activity of the ovaries. . . .

"*Technique of Application:* In every case a preliminary curettage was performed and the curettings examined to eliminate the possibility of carcinoma of the fundus. The radium, protected by platinum and rubber, was inserted to the fundus of the uterus, where it remained for from eight to thirty hours. In by far the larger number of cases the

time of application was twenty-four hours, and the amount of radium employed was 50 milligrams. The patients were discharged from the hospital in three to five days after operation.

"In the light of our review of cases, we are inclined to reduce the dosage to 50 milligrams for twelve instead of twenty-four hours, believing that we will serve an equally satisfactory purpose with possibly fewer menopausal manifestations in some cases.

"*Results:* Nitrous oxide anesthesia is usually employed, and the discomfort to the patient is minimal. The shorter stay in the hospital, with practically no lingering sequelae, is a large factor in hospital economics and favors quick return to working efficiency on the part of the patient. The post operative convalescence is so nearly negative as to make it in no way comparable in danger or possible sequelae to that of even the most ideal abdominal operation. . . . Only very occasionally was the convalescence marked by disagreeable symptoms.

"We have obtained successful results in all but two cases. Five patients were between seventeen and twenty-five years of age; in three of these, the profuse menorrhagia has been reduced to a normal flow. There were five cases between twenty-five and thirty years of age, thirteen between thirty and thirty-five years, sixteen between thirty-five and forty and sixty-one over forty years. In all except two cases, the periods have entirely ceased for intervals varying from two to nineteen months. Amenorrhea may immediately follow the application of radium; there may be one or at most two scanty periods, or slight, irregular bleeding may occur for a few weeks before the permanent amenorrhea is established. In several cases a scanty flow recurred after several months, but this was again followed by amenorrhea.

"Only two unsuccessful results occurred: In the first, a case of chronic pelvic inflammatory disease, the patient's chief complaint was excessive and irregular menstruation. This case was diagnosed incorrectly as one of myopathic hemorrhage, and as a result of the operative manipulation, there was a recurrence of the old process, and two days after the application symptoms of acute pelvic peritonitis developed. An abdominal operation a few weeks later revealed an old infection with a superadded acute process.

"In a second case, the radium failed completely after two 50 milligram applications of twenty-four hours each in the presence of multiple myomata. When the uterus was removed, no visible effects of the radium upon the tumors or the ovaries could be detected.

"Pathologic conditions:

Myoma	60
Chronic metritis	36
Polypoid endometritis	3
Cervical stump	1

100

"Influence on periods:	
Immediate cessation	40
One period	18
Two or more periods	23
Return to normal and regular	15
No relief	2
Not stated	2
	100

"Return of bleeding:	
None	74
To normal after month of cessation	4
Once or twice only, then amenorrhea	1
Profuse	1
	90

"Pain:	
Absent	64
Present	30
Not stated	6
	100

"Nausea and vomiting:	
None	58
Present	25
Not stated	17
	100

"Complications:	
Present (pyometra)	1
None	97
Subsequent operation necessary	2
	100

"Menopausal symptoms (according to age):	
17-20	1
20-25	1
25-30	1
30-35	8
35-40	8
40-45	19
45-50	10
50-55	5
	53
None	37
Not stated	10
	100

In a series of 100 cases of uterine cancer treated by radium, the more or less massive vaginal hemorrhages were completely relieved in

60. There was a recurrence of hemorrhage in 10, and in only 4 was it uninfluenced.

Radium should not be used preliminary to an operation. "In border-line cases of cancer of the cervix, we invariably employ radium. In advanced cases of cancer of the fundus we invariably perform a hysterectomy."

Of the 100 cancer cases, 4 developed rectovaginal fistula and 4 vesicovaginal fistula. There was local healing in 52, no effect in 8, hastened growth in 2.

The average stay in the hospital was three days, while in an operation it is three weeks.

Radium in the Treatment of Cancer of the Uterus.

J. L. Ransohoff (Cincinnati), *Lancet-Clinic*, Vol. 74, n. s., 289, 1915.

"No one who has seen radium used in the treatment of cancer of the uterus can deny its beneficial action at every stage of the disease. The question is how long does this beneficial action continue, and in what stage of the disease should it be used. The results in inoperable cancers are little short of miraculous. The bleeding and foul discharges are arrested in a few days. Even if the cure is not permanent it is worth while to check the terrible symptoms.

"Our dosage is 50 to 100 mgs. radium element, usually the latter. Curretage is unnecessary. After a thorough cerolin douche, the radium in 0.5 mm. silver capsules is introduced directly into the crater, where it is held firmly in place by plain gauze packing. This packing must be accurately done as it serves a two-fold purpose, to hold the radium in place, and to protect the vaginal walls. At this stage a filter thicker than 0.5 mm. is unnecessary, as it is sufficient to filter off the alpha and soft beta rays, allowing the penetration of the hard beta rays which have a rapid action on the superficial masses.

"The first treatment lasts twenty-four hours and is repeated in about a week. The improvement is usually immediate. At the end of the first week, the bleeding and discharge have, as a rule, completely stopped and cauliflower masses have, in some cases, entirely disappeared from the vagina.

"At the subsequent treatments, which are given weekly at first, then every three or four weeks, the radium tubes are enclosed in a brass filter, one-half to one mm. thick, made in the form of a plaque, which radiates the entire uterine area."

This produces less burning secondary radiation. All containers are enclosed in rubber tissue.

In eight months, eight cases have been freed from all signs of cancer. "With one exception, these cases were inoperable and five had submitted to some previous palliative operation. One border-line case . . . is clinically cured. One case had a small non-ulcerating recurrence in the vagina, which disappeared after one treatment."

"Two cases died. Aside from these, there have been no ill effects. We have had absolute freedom from all physical, local and constitutional effects. We have seen no burns of the rectum or bladder and little

rectal or vesical tenesmus. This may be attributed to the comparatively moderate amount of radium used and the fractional treatment."

Radium Treatment of Three Hundred and Forty-Seven Cases of Cancer of the Uterus and Vagina.

H. A. Kelley and G. F. Burnam, J. A. M. A., 66:2033, June 17, 1916.

The use of radium in sufficient quantities greatly enhances the chance of permanent recovery of patients with uterine and vaginal cancers. In early and good operable cases, the use of radium combined with operation adds greatly to the chance of recovery without a recurrence. The most remarkable fact about the radium treatment of uterine and vaginal cancers is that it often clears up those cases which have extended too far locally and become firmly fixed to the pelvic wall; in other words, cases which are utterly inoperable. The authors have had 327 cases including borderline cases, of cancer fixed to the pelvic wall, great massive cancers choking the pelvis, and many in which there were general metastases and the radium was used to bring relief alone. Over 20 per cent of this group have apparently been cured. In a large number of those who were not cured, the discharges stopped, pain ceased, and health was built up.

The Treatment of Cancer of the Uterus.

H. Schmitz, J. A. M. A., 77:608, August 20, 1921.

The objects of this study are to discuss the prophylaxis of uterine cancer, to review the diagnosis of carcinoma of the uterus, to group correctly the various stages of the disease, and to base the indications for a correct treatment on such a grouping.

Cases which are clearly localized after a physical examination are operable cases and are treated by abdominal panhysterectomy. Cases which appear to be doubtfully localized after a physical examination—borderline cases—and operable cases which are poor surgical risks owing to complicating constitutional disease, form the ideal group for radiational disease, form the ideal group for radiation therapy. Cases in which a demonstrable invasion of the contiguous tissues and organs and regional lymph-nodes is found on physical examination are clearly inoperable and are subjected to intensive radiation. Hopeless and terminal cases are treated symptomatically.

The duration of an application of radium within the cervical canal depends upon the intensity of the radiation striking the rectal mucosa. This limits the extent of the action of radium in the pelvic cavity; the parts lying near the bony periphery do not receive an adequate dosage. This may be remedied by supplementing radium therapy by intense doses of x-ray. Surgery in connection with such treatment is not advisable, as these patients undergo a profound radiation toxemia, and succumb easily to sepsis and shock. The technic for combining x-rays and radium is outlined.

In the treatment of recurrences, the radiation must be as intense

as though the uterus had not been removed, regardless of the consequences. The disease and not the patient must be treated. Pre-radiation curettage and cauterization for post-radiation panhysterectomy in the clearly inoperable cases render the patient's chances for even temporary improvement decidedly worse. An active immunization is produced by the action of radium on malignant cells, the cancer cells being stimulated to produce a specific antibody for other similar cells in the tissues of the patient being treated. Hence it is inadvisable to remove cells, the presence of which are necessary for the production of an antibody.

From April, 1914, to December 31, 1919, 168 cases of uterine cancer were treated with radiation. In some cases treatment was preceded by surgical procedures; as hysterectomy or cauterization, and in others radiation was followed by hysterectomy. Since 1918 radiation was used exclusively. The results show as apparent cure: 71.4 per cent. operable cases; 54.5 per cent. borderline cases; 27.9 per cent. inoperable cases; 2.5 per cent. terminal cases, and 2.2 per cent. of recurrences.

SECTION III B
CANCER OF THE BREAST

United States Radium Corporation
New York

SECTION III B

CANCER OF THE BREAST

Radium Combined With X-Ray Treatment in Carcinoma of the Breast.

George E. Pfahler, Am. J. Roentgenol., 8:661, Nov., 1921.

Successful radiation treatment of the breast depends upon a clear recognition of the extent and nature of the disease and upon the most thorough and careful application of the radiation to every portion of the malignant tissue for sufficient time and with sufficient intensity to destroy every malignant cell. The roentgenologist should study the whole question of carcinoma of the breast and its treatment as thoroughly as does the surgeon.

Pfahler recommends in operable cases an ante-operative course of x-ray treatments over the breast, axilla, and supraclavicular region, as much radiation as possible being given to the tissues within a period of one or two weeks. Radical operation should be done within a few days, and soon after (within three or four weeks after the first x-ray treatment) a second course of radiation should be given, to the limit of skin tolerance, the whole process being completed within two months in an early or average case. If the disease has been extensive or if metastasis in the supraclavicular region or mediastinum has occurred, the treatments will have to extend over a longer time and be more thorough. At least three areas should be treated: the mammary region, the supraclavicular region, the scapular and posterior axillary region.

Pfahler uses the radiation from a Coolidge tube, excited by a transformer, through 6 mm. of glass or aluminum, with a 9 in. spark-gap and 5 milliamperes of current. With a focal skin distance of 30 cm. an exposure of twenty minutes is given; when the distance is increased to 40 cm. the exposure is made for thirty-five minutes. Each of the areas is covered twice within a period of two weeks. The longer treatment is preferable, except for the radiation sickness which usually follows.

In inoperable cases the best results are obtained by treatment similar to the above, in combination with radium. The earlier it is begun, the better are the chances of success. Two weeks after exposure to x-ray, steel needles, containing 10 mg. of radium each, are placed throughout the tumor mass, at distances of 1.5 cm., if the treatment is to last for eight hours, or at distances of 2 cm. if the treatment is to be for sixteen hours. The needles must be introduced under aseptic precautions and into every part of the tumor, either at a single application or within a period of one week. As a result the tumor usually disappears or shrinks so that operation is possible. In recurrent carcinoma the same method of treatment is followed. If the disease is localized to the area treated, good results may be expected. Patients should be kept under observation and should report for examination at increasing intervals for an indefinite time.

Radium in the Treatment of Carcinoma of the Breast as an Adjunct to Surgery.

Ben R. Kirkendall, Am. J. Roentgenol., 8: 668, Nov., 1921.

Kirkendall believes that radium therapy, after a radical operation for cancer of the breast, greatly lessens the chances of recurrence, and in local recurrences often meets with success. In the non-operative cases—those which were inoperable, and those which would not submit to surgery—the results obtained by radium treatment alone encourage its continued use. The preoperative and postoperative use of radium in cancer of the breast is highly recommended particularly in virulent cases. Kirkendall's cases are grouped as follows: (1) postoperative, in which radium was used directly after a radical operation, 43 cases; (2) postoperative recurrences before radium was used, 44 cases; (3) non-operative, 10 cases; (4) cautery, the disease being too far advanced for any other surgical treatment, 4 cases; (5) preoperative and postoperative, 8 cases. Of these 109 cases, 11 were unimproved, 29 were improved for three months, 12 for six months, 6 for nine months, and 14 for one year or longer; 5 have been free from the disease for three months, 7 for six months, 4 for nine months, 9 for one year, 4 for eighteen months, 2 for two years, 2 for thirty months; 1 abandoned treatment; 10 could not be traced. Fifty-three patients are still living.

The best results were obtained with 100 mg. surface pack, four 1 mm. brass tubes, containing 25 mg. each being placed side by side between double thicknesses of black vulcanizing rubber, cured on one side only.

Squares the size of the pack were marked off on the binder over the dressing, which was made of 1 cm. thick, and the entire breast, axillary and clavicular areas were treated with four hour applications. When operation was performed the same pack was used, but over 1.5 or 2 cm. of gauze, and each area was treated twice, once before operation and again immediately afterward, and for only three hours. The skin reaction after this double exposure may be disregarded. In recurrent cases a pack of 50 to 75 mg. was applied, with little or no gauze interposed, or radium needles were embedded in the mass for from three to eight hours.

Radiotherapy in Cancer.

R. H. Stevens, Grace Hospital Bull., 4: 39, Apr., 1920.

In treatment of breast cancer the author believes the patient's best interests are conserved by careful and deep therapy of the growth and the afferent and efferent lymphatic system over a period of several weeks, several series being given two or three weeks apart before the operation is done. Then the operation should be limited almost wholly to the original growths, leaving the slightly affected axillary glandular system to the x-ray treatment. The secondaries of cancer generally respond much more readily to x-ray and radium than do the primaries. Swelling of the arm from obstruction of the lymphatic circulation is common on the operated side after amputation of the breast, because of too radical an operation.

X-ray treatment and radium are perhaps the best agents we have

today for the treatment of cancer, but they are not specific for all types of malignancy. The nearer the cell approaches the highest differential type the less sensitive it is to the action of the rays, the squamous-celled growth accordingly being the most resistant. Growths of this type should be destroyed by electro-thermic (diathermic) coagulation, according to the method of Wm. Clark of Philadelphia, using nearly an ampere of d'Arsonval current (bi-polar) with the patient thoroughly anesthetized. The growth is first blocked by inserting the needle connected with one pole of the d'Arsonval current into the tissues all about it, a few seconds in each place, till the tissues are cooked, and then through the growth itself until the whole is cooked. It is then curretted or cut away. The resulting wound heals kindly leaving a smooth scar. Recurrences are not frequent in the neighborhood. Squamous-celled growths, however, metastasize early and x-ray treatment should be intelligently carried out for some time to the afferent and efferent lymphatic systems.

Operation should not be done after x-ray or radium therapy until the local sound tissue and the blood have had a chance to recover from the primary action of the rays, i. e. two to four weeks. Post-operative treatment should be kept up for several weeks.

Radium Therapy in Cancer at the Memorial Hospital (N.Y.)

H. H. Janeway: pp. 184: 190. (P. B. Hoeber, 1917).

The best results in radium therapy are obtained in primary tumors, because recurrent growths are unusually so wide-spread that temporary improvement is all that can be gained. One case of primary operable growth of the breast was treated by the author, using one excessive treatment, causing the patient considerable suffering, but resulting in apparent cure. The treatment used was 5 plaques; 250 m. c.; 1 mm. silver covered with rubber; directly on surface of growth; 12 hours. The treatment of one of a group of patients with advanced recurrent cancer of the breast who were much improved by treatment was: 12 plaques; 600 m. c.; 3 mm. lead; 2 cm. wood; directly over nodules; 7 hours. Eight weeks later there was considerable retrogression of all nodules. Three weeks later this patient received 4 plaques; 300 m. c. 3 mm. lead, $\frac{1}{4}$ inch gauze; 12 hours. After an interval of eighteen weeks received 4 plaques; 240 m. c.; 2 mm. lead, 2 cm. wood, 6 hours; to supraclavicular glands, and 1 plaque; 100 m. c.; 2 mm. lead, few layers gauze; directly to each cutaneous nodule, 6 hours.

In many cases of cancer of the breast the tumor is deeply situated and the breast is fat and very mobile. These conditions render its treatment by radium somewhat difficult. The site of the regional lymphatics is some distance from the breast, and somewhat inaccessible to radium therapy. Further, many cancers of the breast, those for instance having a relation to a chronic mastitis may be diffuse and the suspected tissue involved of considerable volume. Well-situated for radium treatment are well localized tumors of the breast of small size, where there is no excess of adipose tissue. As they form small nodules discrete and set apart from the rest of the breast, they are satisfactorily covered with a radium applicator. The success of treatment will depend on how far the

disease has invaded the lymphatics. The use of radium can be offered to those patients who dread and refuse operation, and it should also be useful in cases where the wisdom of using the knife is doubtful. The author does not recommend radium as a primary resort in mammary cancer.

Inoperable Carcioma of the Breast, Clinically Cured by Radium.

J. L. Ransohoff, Lancet-Clinic, 112: 618, 1914.

The author reports a case of cancer of the breast which was inoperable because of a severe myocarditis and nephritis. The patient had some months ago presented a scirrhus cancer in the upper outer quadrant of the left breast. Radium treatment was begun in April 1914. The tumor at that time was hard, nodular, infiltrating and about half as large as a fist. There was no palpable involvement of the axilla. The patient received three treatments, of twenty-four hours each, with 100 milligrams of radium, filtered through one-half millimeter brass, and one centimeter cotton, using the cross-fire method. At present there is absolutely no evidence of tumor in the breast.

SECTION IV

RADIUM IN MALIGNANT DISEASE,
CANCEROUS AND BENIGN GROWTHS

United States Radium Corporation
New York

SECTION IV

RADIUM IN MALIGNANT DISEASE, CANCEROUS AND BENIGN GROWTHS.

Treatment of Malignant Conditions with Radium.

William J. Young, Kentucky M. J., 19:778, Dec. 1921.

Massive dosage, to the limit of the patient's endurance, with reactions as a guide (except in conditions which have greatly lowered resistance) is the first rule to be drawn from Young's results. The exception, however, is as important as the rule. Coöperation with the surgeon is always desirable; indeed, the line between operable and inoperable malignancy cannot yet be so well defined but that the surgeon's position may depend upon his acceptance of radium as an adjunct. Nor is the ground so solid under the radiotherapist that he should lead patients to expect the miraculous. All radium treatment should be augmented by x-ray treatments.

In breast cancer the x-ray will do better work in a shorter time than will radium, except for direct insertion of the latter at special points of invasion. Numerous surface lesions are here shown in photographs, with the most marked absence of scar after healing following radium application, always in the maximum dose, and seldom needing a second treatment. In the mouth, tonsils, nares, nasopharynx, esophagus, and trachea, with dosage just short of a burn, the percentage of cures has greatly increased. A case of cancer of the ampulla of Vater, in which radium was anchored through an incision, left for the prescribed time, and withdrawn through the mouth, shows at least temporary improvement. Cancer at the pyloric end of the stomach shows like improvement after a dose of 50 mg. radium, lowered on a string through the esophagus, allowed to find its way to the lesion under fluoroscopic observation, and withdrawn through the mouth. Patient becomes able to eat anything he wanted. Treatment was repeated after eight weeks. Uterine cancer, if in the fundus, is preferably for surgery; if in the cervix, decidedly for radium. Young's usual dosage is 150 mg. radium in 3 series, 50 mg. on each side of the external os and 50 mg. within the cervix; a total of 6,000 milligram hours. Undertreatment means recurrence in from four to six months. Cancer of the bladder and prostate gland are best treated by direct application of radium through a suprapubic opening. Malignancy of the rectum, when low, is for surgery, reinforcement by radium; when high, the only successful technic is direct application of radium through colostomy opening. A few inoperable cases are thus rendered operable.

Radium Treatment of Hemangiomas.

A. Beck, Münch. med. Woch., 68:1248, Sept. 30, 1921.

The author reports suprisingly favorable results following the treatment of cavernomas by radium rays. The course and the action of this treatment were such that a considerable increase in the angiomas took place for the first eight or ten days, and the skin and mucous membrane revealed an inflammatory reaction. After another two weeks the tumors began to grow smaller and finally almost entirely disappeared. The radium treatments were long and intensive, but the author thinks that if he had had better and stronger preparations, the dura-

tion of the treatment could have been greatly shortened. The filtration took place through 1-3 mm. lead, 1-2 mm. rubber, and several sheets of paper or cellular tissue. Consequently, only gamma-rays and, among these, only the hardest ones, were employed. The use of the undoubtedly very active alpha-rays or beta-rays can be recommended only for superficial angiomas. An exact filtration which can be obtained in the way indicated is of importance. It is also absolutely necessary to continue the radium treatment while the tumors are growing. This also furnishes a standard for the dosage.

The author's report refers to 3 cavernous hemangiomas, 2 of which had already been treated once by radical operation and by alcohol injections, but had relapsed after a few years, and presented a progressive growth. A further operation would not only have been very dangerous, but it could not have been very radical, for technical and cosmetic reasons. Other methods might have been used, such as chemical remedies, galvanocauterization, ignipuncture, or electrolysis. However, none of these treatments would have been without danger. They might have caused thrombosis and embolism or infection. They would also have been quite painful, and it would have been necessary to repeat them several times, whereas the radium treatment—aside from slight inconvenience—was not at all painful, and was much less dangerous than the other methods.

The Response of Various Types of Cancer to Radium.

Douglas Quick, J. M. Soc. New Jersey, 18: 350, Nov., 1921.

Radium is not a "cure-all" but is the greatest single agent at our disposal for combating malignant disease, sometimes producing a complete regression of the disease and sometimes supplementing surgery in producing the greatest good. In many cases palliative relief may be afforded for some time with radium where no hope of a complete regression could be entertained. However, there is a limit beyond which it is useless and harmful to proceed. Radium reactions are painful in certain types of cases, and this is one reason for withholding the treatment in hopelessly advanced cases. This, however, does not include all inoperable cases. Certain groups of conditions are now treated only by radium. Generally, rapidly growing cellular tumors respond much more rapidly to radiation, but the end-results are equally unstable, because of the danger of early and widespread metastases. Osteogenic sarcomas of bone are little improved by radium or radical surgery. Neoplasms which tend to remain localized and to metastasize late in the course of the disease are most amenable to treatment; those which metastasize locally, only, are more suitable than those which extend widely and early; and tumors extending through the lymphatics are usually more amenable to treatment than those spreading through the blood stream. Nerve and dense fibrous tissues are more resistant to radiation than is epithelial tissue, and endothelial tissue is promptly affected by radium. It is best to give one large dose to obtain complete regression of an epithelial tumor, for later inflammatory reactions are distinctly painful and lower the patient's vitality.

Radium may be applied as filtered radium placed on the surface or at a distance from it, and as unfiltered emanation buried in the

tumor tissue, the most important factors being accuracy and intimacy of application. For many lesions, the use of filtered radium over the surface is quite sufficient to produce a complete regression of the disease, but this is extravagant because much radiant energy is being wasted and the greatest intensity of the dose is being delivered to the least vital part of the growth. Radium emanation decreases in value at a definite rate, and thus can be measured, and may be collected in fine glass capillary tubes which may be embedded in the tissues and left in place. Thus the radiation can be distributed uniformly throughout a neoplasm and placed where it is most needed; all of the radiation is utilized and normal tissues are spared useless radiation. A very marked lymphocytic infiltration is also induced, and this is the greatest single defense of the body against malignant invasion.

In conjunction with surgery, emanation may be buried at any suspicious points within the wound, while it is still exposed; this does not interfere with healing. This method is particularly valuable in neck operations. Frequently a mass is surgically exposed and then found to be inoperable. If there is doubt, emanation tubes should be buried uniformly throughout the mass and the wound closed. Complete regression over periods of from one to four years has followed this treatment. In intra-abdominal new-growths, many cases show a distinct advantage if emanation is introduced into the upper part of the mass by the abdominal route, in addition to the usual treatment below. Radium is particularly valuable in intra-oral carcinoma, and in carcinoma of the larynx, but in the presence of cervical metastases a combination of surgery and buried emanation is advised. Carcinoma of the esophagus is extremely hopeless, and palliative relief is all that can be accomplished. Little has been done with radium in carcinoma of the stomach, but rectal cancer has shown good results. One of the best fields for radium is carcinoma of the uterus, particularly of the cervix uteri, for in the best hands, carcinoma of the cervix has passed out of the operative field. With neoplasms of the bladder and prostate, encouraging results have been obtained, although, in the former, surgical exposure may very often facilitate treatment. Radiation has proven of inestimable value in cancer of the breast, being a valuable adjunct to surgery in operable cases and a blessing in inoperable and recurrent cases.

Surgery and radium both fail in the treatment of neurogenic sarcoma. Giant-cell sarcoma gives good results, but true osteogenic sarcomas are usually unsuitable to this treatment. Some regression occurs, but dissemination through the blood stream is rapid and early, and no means of successfully dealing with these metastases has been found. Radium exerts spectacular effects on the lymphatic glandular diseases, and regressions are very rapid but not permanent, although palliative relief may be given for years.

The intravenous injection of an active deposit of radium has given results of greater promise, but definite conclusions cannot yet be given. Teratoid carcinoma of the testicle produces spectacular results, but dissemination is so widespread that results are not usually permanent. Brain tumors give a variable response, but experimental work indicates that normal brain tissue withstands radiation very well. With parotid tumors results have usually been successful.

Radium Therapy in Cancer.

George Stuart Willis, Med. Rec., 100:793, Nov. 5, 1921.

Much may be expected from the medical treatment of malignancies in conjunction with radium therapy. The two main factors necessary for success in the treatment are: (1) that the growth is accessible to the action of the rays of radium, and (2) that the physical condition of the patient is such that he can withstand the treatment. Our experience at the New York Post-Graduate Hospital has been that it is necessary to treat the patient rather than the growth. For example, in treating a patient who has a hemoglobin content of 55% and only 3,000,000 red blood cells per cubic millimeter, it is impossible to use as large a dose of radium at one time as in the treatment of a patient who has a comparatively normal blood-count. From a urinary standpoint, a phenolsulphonephthalein excretion of less than 50 in two hours is considered a contra-indication for radium therapy.

The use of radium is discussed in (1) superficial cancer; (2) oral, laryngeal, and esophageal growths; (3) uterine, cervical and vaginal growths; (4) rectal growths; (5) carcinoma of the breast. In general 12.5 mg. needles are imbedded into the growth, one needle to each centimeter of space. The treatment of cancer of the mouth, nose and esophagus consists in the application of 10 mg. needles. In many of these cases there was marked diminution in the size of the tumor mass, but few cases escaped infection which proved more disastrous than the original growth. In cancer of the esophagus, the insertion of radium through the esophagoscope, resulted in no cures, but the condition of 4 patients was greatly improved, from the palliative standpoint.

In carcinoma of the cervix, the uterine body and in rectal growths, preoperative and postoperative irradiation should be employed. Great progress has been made in the treatment of cancer of the rectum. A preliminary colostomy is advised in all cases of carcinoma of the rectum. Needles containing 12.5 mg. of radium are inserted under either local or gas and oxygen anesthesia. These needles are applied 1 cm. apart, once a week for four weeks, and then it is usually possible to have some idea as to the amount of further treatment. Willis also uses a tube screened by 1 mm. of gold and 1 mm. of hard rubber, especially made, containing from 60 to 100 mg. of radium, applied daily for one hour. This method has been adopted to prevent sloughing and toxemia, which occurred when massive doses were used at one time. In the treatment of cancer of the breast, it is suggested that the breast be removed by an elliptical incision and that the axillary space be left undisturbed, leaving all postoperative treatment in the hands of the radium therapist.

In the treatment of bladder and prostatic cases, the technic of H. G. Bugbee of New York is followed. While this improved technic has been in force too short a time for permanent cures to be reported, the fact that the initial growth has been removed in each instance seems encouraging as to the future outlook.

Closer coöperation is necessary so that the early use of radium may be proven; further experimentation is needed in order to determine the action of radium on abnormal tissues. Radium should be used in the case of all malignancies before and after operation. The relative value of radium emanation and salts of radium can be determined only after further experimentation.

The Progress in Radium and Roentgen Therapy in the Treatment of Malignancy.

Russell H. Boggs, Internat. J. Surg., 34: 308, Sept., 1921.

Unfortunately, the radiologists trained in therapy are not numerous nor can other men be taught in a few weeks. In treatment one must take into consideration the facts that the virulence of a growth increases with an increase in lymph supply, that it is absolutely certain that radiation will decrease the permeability of the cancer cells by producing a fibrosis of the lymph spaces, that unless all malignant cells are killed the disease will be only arrested and not cured, and that an incomplete operation never cures. Postoperative radiation decreases the number of recurrences, but when more than one chain of lymph nodes are involved the operative cure is rarely possible.

There are four methods of obtaining intensive radiation: (1) by imbedding many needles in the organ involved; (2) by using heavy filtered x-rays through a number of points of entry; (3) by using heavy filtered rays having high voltage over large skin areas; (4) by using a pack of radium tubes properly spaced in order to give off a large amount of scattered rays. By imbedding radium a lethal dose can be given without burning the skin, but in determining the lethal dose one should consider the depths and extension of the lesion as well as the chains of lymphatics most prone to metastases. When a lethal dose is given, radium is the most efficient means of treating malignant growths of the mouth and throat. Some very advanced ulcerated growths have been cured by radiation and coagulation. In breast cases surgery is contra-indicated if the ulceration is large, if the growth is deeply fixed, and if the lymph nodes are palpable and fixed. Imbedded radium and surface radiation make this form of treatment as thorough as amputation. Surface application of radium and x-rays followed by imbedding radium leads to clinical cures without opening the lymph channels; and operation, if later indicated, is performed when nearly all cancer cells are destroyed. The results in carcinoma of the rectum, bladder, esophagus and stomach have been good, but the treatment is more difficult because the growths are obstinate and the affected organs functioning.

Is Radium Therapy a Dangerous Method?

H. Rubens-Duval, Paris chir., 13: 180, April-May, 1921.

Many so-called inoperable cancers which were treated with radium as a last resort have been completely cured, as determined both clinically and histologically. That metastases occur more frequently after radium treatment is due to the type of case which the radium therapist is offered to treat. Most of them have already had the primary growth removed by surgical means. It has been suggested that the radium may liberate only partially devitalized cells which travel to distant parts in the blood stream, but this statement has never been confirmed in any way. On the contrary, surgical procedures can without difficulty cause, by mechanical means, the dislodgment of cancer cells. Clinically this fact is well known and many growths are therefore considered as "noli me tangere." Some have thought that the destruction of cancer cells by radium might cause the formation of an autovaccine, thus protecting the organism from metastasis. This is not true. It is possible, however,

that the destruction of healthy tissues about the cancer may affect the line of defense which has been formed against the growth. Incomplete removal of the original growths has been followed by cure. It would seem that in these cases the body was able to overcome the remaining cells. Partial radiation may cause stimulation of cancer cell growth. Radium does not cause metastasis but it may activate that which is already in existence, and in this respect is not unlike the surgical means of treatment. Severe burns, sloughs and neuritis have done much to give radium a bad name, but are not as numerous as appear at first glance. The more careful infiltration methods have reduced these complications materially. The use of radium should be confined to specialists.

That radium has caused the spread of infection has not been proven, since the surgical procedures (such as curettage and dilatation of the cervix in uterine cancer) are just as responsible for this result as is radium. Vomiting, insomnia, febrile reactions, and radiotherapeutic shock are uncommon and last for variable periods, but generally terminate after the radium is removed. Whether these reactions are due to destruction of red blood cells or to absorption of toxic products from cancer cell destruction is a question. In nephritic, diabetic and cachetic individuals radium must be used with caution for this reason.

The Treatment of Sarcomas with Radium, and Report of Cases.
S. W. Mowers, Northwest Med., 20:206, Aug., 1921.

Experience convinces the author that operable malignant growths should be treated with radium, in combination with X-ray therapy, before and after surgery, and that inoperable cases should always receive thorough radium and X-ray treatment.

Of 10 difficult cases here reported, only 1 resulted fatally. This was of sarcoma of the left parotid gland, recurring three months after surgical removal; it was ulcerated, with a foul gangrenous discharge, and was entirely inoperable. After five months of treatment with radium, only a slight amount of induration remained, the tissues were soft and movable, and the patient resumed his work without discomfort. Observations were continued until the ninth month, when serious illness led to decompression operation for secondary tumor of the brain; no tumor was found, but autopsy a few days later showed metastasis involving the cerebellum.

Of these 10 cases treated with radium the 9 which showed clinical recoveries were: (1) a recurrent sarcoma of the neck; (2) a recurrent sarcoma of the shoulder, treated for five months; (3) a large mixed-cell sarcoma springing from the left ligament two years after partial hysterectomy for uterine fibroids — there were adhesions so dense that the mass could not be completely removed; it was tied off, a radium tube inserted, and the abdomen closed; healing seemed complete at the end of two and a half months of radium applications; (4) another inoperable sarcoma involving both tubes and ovaries, with intestinal and retroperitoneal masses filling the pelvis, was treated for periods of a month's duration with an equal interval of rest; during the second treatment period the uterus was found to be movable, and only slight induration remained in the ligament; (5) a child $2\frac{1}{2}$ years of age had a palpable, painful mass in the appendiceal region, which upon explora-

tion proved to be inoperable sarcoma. Radium, applied after healing of incision, removed all induration and symptoms before the third month; an examination six months later was negative; (6) a sinus, with recurrent hemorrhages, remaining two years after a thyroid operation, with marked symptoms of involvement of the esophagus, confirmed by X-ray, was closed and the thyroid gland reduced to normal size; (7) lymphosarcoma of the throat at the site of removal of a former mass near the left tonsil cleared after five months of radium applications; (8) angioma in a baby, involving the outer aspect of the thigh, with a broken-down and ulcerating center, which appeared to be sarcomatous, healed after five weeks; (9) a large tumor involving the angle and the ascending ramus of the inferior right maxilla, with extensive bone involvement, as disclosed by the roentgenograph, showed clinical recovery after five months. Observations are continued in all cases in which the physician's advice is followed.

Radium Treatment of Cancer: A Plea for Co-operation between Surgeons and Radiotherapeutists.

Wm. J. Young, Kentucky M. J., 19:450, Aug., 1921.

The chief action of radium is to resolve hypertrophic tissue, whether its situation is normal or foreign. As malignancy is the reproduction of a foreign substance in normal body tissues or organs, it should be amenable to radium therapy. Insufficient dosage with either radium or roentgen ray has the effect of stimulating the process. Massive dosage is not as easy with the unstable factors in roentgen ray application as in radium treatment. However, burns are of slight consequence in the prospect of a cure as compared with the alternative. In treating skin cancer, the aim is to produce a clinical cure by one dose of radium. If failure should follow a third dose, surgery is recommended in the author's cases. No agent is as effective as radium in the treatment of precancerous lesions of the skin. Basal cell epitheliomas are always amenable to massive dosage. Squamous and prickle-cell types are more resistant, and where deformity will not be great, excision is advised, extending $\frac{1}{4}$ in. beyond the diseased area. Radium should then be applied, extending $\frac{1}{4}$ in. beyond the line of resulting scar. If there is infiltration beneath the skin, it is always well to excise and follow with radium. For all malignancy which is inoperable, inaccessible by surgery, or in which metastasis has occurred, radium is the one agent. The roentgen ray should be employed to assist in blocking points of metastasis. Where the avenues of metastasis are extensive, with a large area to be treated, as in breast cancers, the roentgen ray is preferable. In cancer of the uterus, if the disease has involved the abdomen, radiation below may give rise to stimulation above. Carcinoma of the prostate should always have radium, preferably applied through a suprapubic opening, whether or not surgery is employed.

The Treatment of Tumors by X-Rays and Radium.

Robert B. Greenough, Boston M. and S. J., 184:622, June 16, 1921.

The process of development of the latent effects of radiation on the living cells is unknown. Unabsorbed rays have little effect on

the tissues through which they pass, the penetration of the different rays following a definite physical law. The tissues show differences in susceptibility to radiation; cells undergoing nuclear division being especially vulnerable and certain types of cancer cells being affected 4 to 7 times more readily than healthy cells. By radiation living tissue may be destroyed *en masse*, growth may be temporarily inhibited, or its rapidity stimulated and the manner of growth may be modified. The massive destruction of complex tissue demands a dose of radiation sufficient to kill all the different cells; but in treating non-malignant disease and in the palliative treatment of cancer, all of the cells exposed to radiation need not be destroyed. To cure cancer all cells must be destroyed. Direct radiation is particularly effective with non-metastasizing carcinomas of the skin in both squamous and basal-cell varieties and may be used when operative removal is impracticable. The insertion method—using bare tubes of emanation or the needles holding radium salts—or emanations at their tips produce death *en masse* of the tumor tissue but can be used only on the surface of the body. Inside they cause deep, dangerous infection. Beta-rays are best for massive destruction. X-ray cancer may result from long-continued and slowly healing X-ray burns. New growths in blood vessels and connective tissues are the first histological change after radiation and appear before changes in the epithelial cells. With papillomas and keratoses, a mild treatment is given, the cells grow normally, abnormal cells are cast off, and the lesion is cured without a scar. Lymph-adenoid, ovary and testicle tissues are especially sensitive to radiation and so are tumors in those tissues. Surface cancers are curable, cancers of the mouth are more resistant. Advanced cases of squamous-cells or glandular cancers may be helped by stimulation of the connective tissue growth. Cancer tissue contains many cells engaged in mitotic cell division and cells in this condition are particularly sensitive to radiation. If only the cells in mitosis are affected by the treatment, other cells may grow later. Repeated exposures to radiation produce a gradual loss of sensitiveness. Massive destruction effect of radiation by direct application is necessary to cure malignant disease.

Treatment of Angiomatous Tumors with Radium.

M. Degrais, Bull. et Mém. de Soc. de Chir. de Paris, 46: 572, 1920.

The gratifying results obtained from the treatment by radium of angiomias have been communicated to the Academy of Medicine more than twelve years ago and it is interesting to note the persistence of the good effects. Mons. Degrais insists on the superiority of this mode of treatment over that of divers therapeutic processes. Radium does not require anesthesia, is painless, does not scar. It causes diffuse vascular spots as well as large, limited tumors to disappear; it is efficacious against mucous angiomias (lip, cheek, tongue, soft palate), and presents no danger to the neighboring organs, when the tumor is localized, for instance on the eyelid or on the parotid gland.

Experience has shown the author that angiomias are the better eradicated the sooner they are treated, therefore this may be undertaken during the first months of life and babies can tolerate perfectly the dressing which holds the apparatus; on the contrary other mediums of treatment can hardly be undertaken with safety until a later age, which allows the tumor to develop.

SECTION V
RADIUM IN DERMATOLOGY

United States Radium Corporation
New York

SECTION V.

RADIUM IN DERMATOLOGY

Radium in Dermatology.

C. J. Brocman, Ohio State M. J., 17:841, Dec., 1921.

During the past year, Brocman has had under treatment about 50 cases of the basal-celled variety of epithelioma, located on the face, neck, ears, scalp, arm and thigh. Radium has been employed in all the cases, and the results have been uniformly favorable. In epithelioma of the eyelid, radium therapy was especially successful. With the prickle-celled type, located on the face, forehead, mouth and tongue, the writer has not been so successful. He believes this to be because in such a malignant growth, prone to metastasis, nothing can be accomplished unless treatment is undertaken very early. All his unfavorable results were in cases of long standing. If radium is applied early enough, it will seldom fail to cure any form of cutaneous cancer. The prompt treatment of any suspicious nodule, whether it is possible to differentiate between the basal or the prickle-celled type or not, would greatly increase the percentage of success. In applying radium to the superficial basal-celled epithelioma, the half-strength, 10 mg. plaque is the most desirable apparatus to use. In treating epithelioma of the eyelids, or even of the eyes themselves, sometimes the plaques will suffice, but more often tubes are necessary, especially when the inner canthus is involved. It is important to administer all treatments within ten days, so that the last treatment will be finished before the reaction occurs. For the treatment of prickle-celled carcinoma of the face, from 50 to 100 mg. of radium should be applied, with heavy screening, such as brass or lead, at a distance varying from $\frac{1}{4}$ to 1 in., the exact dose and technic depending upon the conditions at hand. Secondary glandular involvement should receive deep massive treatment, but if the glands do not respond promptly to the rays, surgery should be employed. A case of endothelioma, of twenty-four years' standing, involving the right parotid gland, showed no sign of recurrence after a year and a half, disappearing after three treatments of 600 mg. hours each. In cancer of the lip, when no glandular involvement has occurred, radium is preferable to any other means of treatment. At least 50 mg. must be used, preferably in the form of one or two 25-milligram tubes. The first application should be for at least six hours, and the tube should be well screened with at least $\frac{1}{4}$ in. distance between the tubes and the surface of the lip. As a prophylactic measure, deep radium exposure should also be given to the cervical region, but where the glands are enlarged the use of radium should be confined to the lip and the glands extirpated by surgery. Good results have been obtained with the large tuberous vascular angiomata, and the so-called "port-wine stain" may be greatly improved if treatment is begun early in life. The spider nevus is best treated by the electric needle. In handling either the

pigmented or vascular nevi, care must be observed not to overtreat the patient. In applying radium to keloids the size and location of the growth must be taken into consideration. The plaque will give good results if the keloid is small and of not too long standing.

Radium Treatment of Leukoplakia.

E. Lekisch, Wien. klin. Wchnschr., 34:462, Sept. 22, 1921.

Leukoplakia, even when not syphilitic in origin, often requires treatment on account of subjective symptoms or on account of the danger of carcinoma. The usual treatment with the silver nitrate stick is dangerous because the repeated irritation may stimulate the development of carcinoma. The author believes radium to be the best of the various methods of radiotherapy. Riehl says that the subjective symptoms are favorably influenced by irrigation of the mouth with water containing radium emanation (50,000 to 200,000 Maché units to the liter). For treatment, a flat container is used in which a thin layer of radium barium sulphate is placed and filtered through a metal plate, 0.2-0.3 mm. thick, which excludes all of the gamma rays and most of the beta rays. If desirable to filter out all the beta rays, a thicker metal plate should be used. To exclude the secondary rays the container is surrounded with a layer of wadding and gutta percha, 0.5-1 cm. thick, and 12-23 mg. of radium is placed in the container. The treatment lasts from one-half to one hour, often longer, and is repeated every two weeks. If there is a marked inflammatory reaction, the intervals may be lengthened. In all cases complete clinical recovery and freedom from symptoms were obtained. A severe kraurosis vulvae was cured by 8 treatments with 23 mg. of radium.

Radium Technic in the Treatment of Malignant Diseases of the Skin.

Douglas Quick, Arch. Dermat. & Syphilol., 4:322, Sept., 1921.

Special applicators for radium as now used at the Memorial Hospital, New York, were evolved from the work of the late H. H. Janeway. Exclusive use of radium emanation affords a wider range of usefulness; it can be used in tubes of a variety of strengths; silver, platinum and glass are the filters preferred. There are three special applicators, made respectively of wood, lead-foil and dental wax. A fourth is a steel cone devised by Duane of Huntington Memorial Hospital, Boston. On a wooden block radium tubes are held in place by paraffin poured over them. The block, 5 mm. thick, is held to the lesion by adhesive strips. Where brief applications are desired, two ordinary wooden tongue depressors, strapped together, hold radium tubes at one end and furnish a long handle by which the operator can

hold them to the lesion. On the lead-foil, 0.1 mm. in thickness, an active deposit of radium is used and the foil is folded as a filter, cut (with long scissors held away from the operator) and placed to cover the exact area of lesion. This is especially used for lesions about the eyes. Concentration is regulated for applications of a few minutes by the use of long forceps held well away from the operator. Accurate approximation and comfort to the patient are the advantages of this method. Ordinary dental modeling compound, placed in hot water until it becomes pliable, is placed over the lesion and radium tubes are pressed into it. Approximation is perfectly maintained. An illustration of an applicator made for a lesion on the side of the face shows a concave mold with radium tubes embedded in the inner surface; a photograph shows it applied, firmly adhering to the face, *en contour*. The steel cone has a flat base, an opening in the center, and one or more grooves in its top. The tubes are placed in the grooves; contact with the lesion is through the opening; the steel container eliminates all appreciable radiation extending laterally; it is used for such lesions as those behind the ear, where surrounding parts must be protected. Adhesive strips hold it. For interstitial insertion into lesions requiring it, small glass capillary tubes of radium are loaded (by a special type of forceps) into a trocar needle.

Radium Therapy in Lupus Vulgaris.

Josef Kopp, Strahlentherapie, 12: 469, Berlin, April 20, 1921.

Radium therapy is still the principal method for all cases of lupus which still show foci in the mucous membrane of the nose or of the outer throat, either isolated or with diseases of the outer skin. Flat foci lying in or a little below the level of the skin are especially adapted to this therapy. The radium preparations are put in new silver capsules of 0.2 mm. wall thickness which absorb nearly 67% of the beta-rays. Copper filters 0.2 to 0.3 mm. in thickness should be used. The Dominici tube of platinum, the walls of which are 0.3 mm. in diameter, are used for the nasal mucous membrane and for single hollow cavities. The healthy skin is protected with several layers of lead sheets with covers of rubber or thick paper. The dosage of the radium treatment was generally arranged so that from 75 to 112% of the skin dose was applied at intervals of four to five weeks. Too violent reactions in the form of superficial ulcerations were always an indication for increased caution either in the lengthening of the intervals between the single applications or in the diminution of the single doses. Foci which were exposed to more than 5 or 6 single doses (from 80 to 100% of the erythema dose) without being healed, no longer belong to the group of lupus cases that can be cured by radium. The writer now believes in preliminary treatment of cases with from 2 to 4 x-ray seances of from 5 to 6 H each with 2 mm. aluminum filter corresponding to a hardness

of 1.8 cm. half value stratum. Then from two to three radium seances were given of from 0.9 to 1% of the erythema dose. The cosmetic results are highly satisfactory and the skin remains soft and smooth. In lupus affections of the conjunctiva several cases were cured in from four to five seances of from 50 to 60% of the skin dose, with from 0.1 to 0.2 mm. of copper filter. Contraindications are congenital hypersensitiveness to radium, active hyperemia and general cachexia. Radium therapy succeeds, however, only in a minority of cases in causing the complete disappearance of lupus without influencing the surrounding tissue. The results are better when the surrounding tissue becomes slightly inflamed, that is, when the erythema dose is somewhat exceeded and therewith the histogenous antibody formation is furthered.

Radium Treatment of Vascular Naevi.

Laborde, La Médecine, 2: 696, 1921.

In treating naevi which invade the face it is important to consider cosmetic results. It is therefore very important not to produce inflammatory reactions. The treatment of vascular naevi often demands the use of radiation that is not very penetrant, which requires great prudence, for if the sluggish beta rays have an incontestable curative value on certain lesions, they require extremely delicate handling. In fact, the doses susceptible of an elective action are very close to those of inflammatory or necrosing doses. Between the elective, therapeutic and the caustic dose, the limit is narrow, and the utilization of slightly penetrating radiation requires an exact knowledge of its action. Its use has the advantage of permitting considerable reduction in the duration of the irradiations, and thus an appreciable amount of time is gained. This consideration is of much importance when dealing with babies, in whom the angioma is situated in the neighborhood of the nervous centres. Applications of long duration, in the neighborhood of the nervous centres, are dangerous in the case of infants, because they may produce grave vascular lesions.

(Apparatus is described.)

Treatment of small angiomas: A cure may be obtained in 4 or 5 applications of 30 minutes each with intervals of 5 to 6 days, by using a flat apparatus containing 4 milligrams of radium element per square centimeter and filtered by 1/10 millimetre of aluminum and 2-3 millimetres of gauze. An interruption of two months should follow before resuming the treatment, if a cure has not been reached during the first series of applications.

Treatment of deep angiomas: In this case it is necessary to use more important doses of radiation. To treat, for instance, a vascular, subcutaneous tumor of the cheek, one may place the apparatus on the side of the mucous membrane and on the side of the skin. Apparatus containing an average of four milligrammes of radium element per square centimeter, filtered by 5/10 millimetres of lead, 3 millimetres of rubber are allowed to remain in place 6-8 hours. It is impossible to limit here the number of sessions necessary, this depending upon the

tumor, conditions, etc. Angiomas of the lip are treated in the same way.

Treatment of portwine spots: Extreme care should be taken to avoid any inflammation of the skin. In most cases it is better not to try to obtain a complete decoloration, but to stop treatment when the skin has reached a rose tint. This treatment requires patient persistence.

One may proceed in the following manner: The first series of irradiations are given in sessions of 40 minutes with an enamelled apparatus containing 2 milligrams of radium element per square centimetre, filtered by 1/10 millimetre of aluminum and a few layers of gauze. There are consequently two sessions in 15 days for each zone treated. After an interval of two months, a second series of irradiations is undertaken with the same apparatus, the rays being filtered by 3/10 millimetre of aluminum, the sessions lasting 2 hours. After an additional interval of two months, an irradiation of 12 hours duration is given with the same apparatus, the rays being filtered by 5/10 millimetre of lead and 5 millimetres of gauze. These applications are thus renewed every three months until a partial decoloration is secured.

Some Complications Observed in the Treatment of Angiomata with Radium.

William S. Newcomet. Urol. and Cutan. Rev., vol. 24, pp. 602-606, October, 1920.

It has been generally recognized that moles and other forms of angiomata are often the focal spot for some malignant degeneration. For this reason it is advised that all angiomata be treated in early life, or as soon after discovery as possible. Many of these malignant cases result from what is often diagnosed as "birth-mark." In the average case radium will give by far the best results in the treatment of angiomata. Their removal by the surgical procedure does not always accomplish the desired result, due to the fact that these vessels are not normal, and, when their circulation is impeded, are apt to undergo further dilatation. The writer cites two such cases.

The first case, a woman, developed a hemangioma upon the forearm, extending down over the wrist and upper part of the hand. Most of it was removed by operation. A careful dissection was undertaken, although it was found impossible to follow all the ramifications through the cellular tissue. A few days after operation it had again developed, and was about one-fourth the original size. The forearm and wrist were "cross-fired" with radium and this absolutely controlled the enlargement and caused it to subside.

The second case was treated some years after operation. In the interval the mass had reached its original size. The patient, a male, a professional dancer, had a large hemangioma under the right axilla which extended backward over the shoulder and downward over the area of the scapula. This was removed, but recurred in a few months. This occurred seven years before patient came under Newcomet's observation. The rubbing of the garments frequently caused the lesion

to bleed and caused much discomfort. In addition several small keloids had also formed in the scar of the operation. Radium was employed in three sittings about six weeks apart, and applied over twelve different areas, totalling 5,400 milligram hours. One millimeter of lead and about a half-inch gauze was used as a filter. There was very little reaction, and the patient was able to continue his work during the whole period of treatment. The angioma has disappeared, although a few small keloids remain. In cases where time does not permit a thorough radiation a mild radiation is advised which should precede surgical intervention or one of the electrical methods.

Although Newcomet considers radium as the ideal means of treatment in most cases, destroying all the undesirable tissue and leaving a perfectly healthy skin over the site of the former lesion, there are some cases in which its use has not proved entirely satisfactory. Among these are mentioned cases formerly treated with some cauterant, heat, chemical or electrical methods. Several cases have come under the writer's observation where CO_2 , ice or hot water had been employed, and in each instance resulted in only a partial destruction of the nevus, beside often leaving a sloughing ulcer. In these cases, although the application of radium need not be modified, it must be remembered that more scar formation is to be expected. However, when there is apparent atrophy in the skin structures radiation should be withheld, for if the application of radium is pushed beyond the limit of tolerance, ulceration of long standing is likely to result, followed perhaps by the development of telangiectasis or keloids. The same results are seen where radium fails to produce the desired result, and the application is pushed. This causes a severe reaction of the tissues, which is usually followed by ulceration and scarring. This applies to the type of large, thick, pigmented angiomas or hemangiomas with large vessels, and covered with a thick, leathery tissue.

Again, if some inflammatory condition of the skin develops during the course of radium treatment, when the reaction is at its height, disastrous results may follow, as was observed by the writer in two cases, one of measles and one of erysipelas.

While the reaction is at its height, care must be taken to guard the part from trauma. This would apply especially in the case of young children, where rubbing of the affected part results in ulceration. In these cases, the ulceration is liable to cause scarring.

Further, the writer says: "Barring these cases where the area of the defect is about one centimeter in diameter, the hemangiomata are the most common. The difference in structure in relation to their treatment by radiation is mainly in the character and size of the vessel and of the amount of healthy skin covering the mass. A few of these will be mixed in structure and pass gradually into the true pigmented mole. With this wide variety of tissue, one can readily appreciate the difficulties encountered in their treatment by radiation. However, it might be said that the greatest difficulty is presented when these lesions take on the character of a 'port-wine stain' or a very flat pigmented mole over an extensive surface. These are the cases that usually result in failure and will develop ulcerations, telangiectasis and keloids upon the slightest degree of over-radiation." With these exceptions, Newcomet believes radium to be one of the greatest agents for the treatment

of angiomata. Judgment must be employed, however, as to when and how to apply radium, also whether some other agent should be used as an auxiliary. It is advised that all applications of radium be made lightly, also that plenty of time should be allowed between treatments. The entire area should be radiated equally. This will give uniformity to the surface and prevent bad edges. Should an operation be necessary, it is urged that it be preceded by radiation; if this is impossible radiation should follow immediately after the operation.

Treatment of Vascular Naevi with Radium.

Montgomery and Culver, Boston Med. & Surg. Journ., 183: 412, 1920.

On March 21, 1918, a baby girl of ten months was referred to the authors for a large, cavernous naevus 1.50 cm. in diameter and 50 cm. high, situated on the inner surface of the left upper arm. At birth it was a small red spot and had grown steadily ever since, and with especial acceleration within the past two months, so that either operation or control was felt to be imperative. Its surface was covered with vascular stellate red patches, and its substance felt like a loose bag. Seventy-five mgms. of radium were applied on the tumor for $3\frac{1}{2}$ hours, which not alone stopped the growth of the tumor, but secured a decided retraction. Two mistakes, however, were committed. Only the radium tubes employed with the silver and brass capsules were screened. The capsules had become radio-active and therefore caustic, and a burn resulted. Where the skin was not burned telangiectasis from the radium was not obtained. The authors now usually employ new coverings of lead, or keep the capsules, when not in use, apart from the radium. They also employed in this case, one plaque which was screened with lead, but too lightly, and no cellulose screen of wood, felt, paper or gauze was interposed. After the first burn, this accident was avoided. After five treatments, scattered through a period of eighteen months, the mother reports that the arm is almost like the other, except for a few superficial dilated capillaries, due, as already mentioned, to imperfect technique.

A female infant, ten months of age, was referred to the authors with a very large naevus of the left cheek. It was a raised, deep red, cushion-like naevus with a rolled border and a sunken center. A strong plaque of radium, 24.23 mgm. over the centre, screened with lead 1.50 mm., wood 2.00 mm. and one thickness of adhesive plaster, and on each side a 25 mgm. tube enclosed in its silver and brass tubes and screened besides with 1 mm. of lead, 2 mm. of wood, and one thickness of adhesive plaster was used and retained in place for five hours. On March 27 a similar treatment was given, but with less thickness of lead (0.40). On May 27, 1919, the tumor was so reduced that only one radium tube could be used over it. This tube contained 25 mgms. of radium element and was enclosed in its silver capsule. Besides, it was screened with lead 1.00 mm., wood 2 mm., and was retained in position for five hours. On November 5, 1919, a similar radiation was given and the tumor was so reduced in size that it is thought no further radiation will be given for a very long time, if at all.

Screening is of the greatest importance and must necessarily vary with the type of lesion treated, with the concentration of the radium preparation employed, and with the time this preparation is retained in place.

"One fundamental principle to bear in mind is that it is far better to err on the side of the screening too much. This precaution is especially necessary when a cosmetic result is wished for, as is so frequently the case in naevus. In the first place there is a difference between screening and shielding. The shield is employed to protect the surrounding tissue. If the lesion is small, a hole for it is punched in a piece of thick lead, say 1 mm. thick. The hole should be a little larger than the lesion. This lead has to have either cellulose (paper, wood or gauze), or rubber between it and the skin to prevent the action of the secondary rays. The surrounding tissues having been shielded, the screen is placed on the face of the radium applicator and then applied and firmly plastered down with adhesive plaster."

The Removal of a Birth-Mark with Radium.

Dr. W. R. Bathurst, Urol. & Cutan. Rev., 22: 55, 1918.

The author believes radium to be the best available treatment for the removal of a vascular nevus. In most cases, however, months are required to effect a cure. A case is cited of a baby, having a growth which covered the upper eyelid to a point a little above the eyebrow, and the disfigurement was accentuated by the growth being of a deep purplish color. The birthmark was eliminated, and but a very small scar left, such as any body or girl might have from a slight burn or fall.

Treatment: 18 hours in fractional doses with 10 mg. radium element. Full strength applicator. Treatment began September 4, 1916, and was continued at varying intervals until a total of 18 hours exposure was given using a 10 mg. full strength applicator with number one brass screen 14 hours, and 4 hours screened with .10 aluminum screen. No exposure lasted over 30 minutes on any one spot.

Radium in Rodent Ulcer — According to Sequeira small rodent ulcers do well with radium. The radium of strength 500,000 units is applied for four hours on a suitable plate, covered with a varnish, and again covered with a single sheet of gutta percha tissue. The applicator is fastened in situ with strapping or a bandage. One such application is often sufficient to cure a superficial lesion of moderate size. The reaction begins in about ten days, and at the end of three weeks a blackish slough falls off, leaving a smooth cicatrix. In some cases the application has to be repeated several times. Where there is a deep infiltration, the radium covered with a thin sheet of lead is left in position for ten, twelve or twenty-four hours. The lead prevents any severe dermatitis, and sometimes the results are remarkably good.

Combination of Specific and Destructive Properties of Radium — Wickham and Degrais point out that sometimes it is well to combine the destructive and specific properties of radium. The possibility of producing rather strong inflammation of keloids, without the risk of

relapse, is due, not only to the special process according to which the repair of diseased tissues takes place, but also the filtration effected by the first layers of keloidal tissue. Indeed, whilst the latter receive intense and massive total doses, the deeper layers are only affected by the more penetrating rays, which, having passed through in small numbers, excite a gentle effect; a double action is therefore simultaneously produced; destruction in the superficial portion of the keloid and specific beneath that region.

Radium in X-ray Burns—A number of x-ray operators are employing radium in selected cases and as an auxiliary. These men are in a way more competent to handle it efficiently, having made a study of radiotherapy in general. Several of them who have suffered from x-ray dermatitis have had resulting lesions cured by radium.

Angioma and Radium.

Gordon B. New, Jour. Lancet, vol. 37, pp. 445-48, Minneapolis, July 1, 1917.

New believes that surgical treatment of angioma is of little value, and advises the use of radium. In his experience, angiomas have not recurred following this form of treatment, as they usually do following any operative measures, while the scarring that results is disfiguring. Small quantities of radium used in the treatment of superficial angiomas or purplish birthmarks bleach out the condition, leaving the skin almost normal in appearance. Extreme care must be exercised, or a whitish disfiguring scar will result. These superficial lesions are best treated by a small plaque of radium kept moving constantly over the involved area. Larger quantities of radium are required for large, cavernous angiomas often seen about the scalp and face of children. It may be used in the form of a plaque or tube properly screened and elevated from the tumor. Emanations may be employed, when available. The best method, however, is to place a tube of radium in a rubber finger-cot, inserting it directly into the tumor. When using this method about the lips and cheeks of children, ether anesthesia should be given. A small incision should then be made inside the mouth a short distance from the angiomas, and the radium inserted directly into the tumor through a channel burrowed with a small, straight forceps. The incision should then be closed with catgut. When done entirely in the inside of the mouth there is no visible scarring and no deformity of the skin. The tumor disappears, leaving a normal condition. It is best to wait two or three months between treatments. Although angiomas in children respond most readily, many remarkable results are seen as a result of treatment of adults. Many cases of extensive cavernous angiomas about the tongue or floor of the mouth, involving the submental and submaxillary regions, which seem hopeless from a surgical point of view, are cleared up when treated by the cross-firing method from the inside of the mouth, and outside of the neck.

Case: Child, 4 months old, brought because of angioma of upper lip. Tumor, noticed at birth, had been increasing in size. No improvement had followed treatment, which consisted of a weekly injection

of alcohol, for six weeks. Examination showed a large cavernous angioma involving entire length of upper lip, and bulging the lower part of nose. The lip was one inch thick in the center. There was a marked eczema on face and scalp. On October 26th, a 25 mg. tube of radium in a rubber finger-cot was inserted into the inside of the upper lip, and left in place for eight hours. On February 1st the lip showed an improvement of about 75 per cent. A 22-mg. tube was inserted into the inside of the lip and left in place for eight hours. The child was next seen on April 10th, when the lip was found normal.

Relative Value of Radium in Dermatology.

A. F. Holding, J. A. M. A., 63:741-43, Aug. 29, 1914.

In malignant lesions of cavities, in which the neoplasm is inaccessible or difficult to expose to direct application of Roentgen rays, such as the esophagus, rectum, vagina, urinary bladder, fauces, etc., radium has greater possibilities than any other similar agent in use at present. One fact that would seem to justify hopes of superior results from radium is that the most penetrating Roentgen rays in use represent the output of a 60,000 to 100,000 volt current, while it is estimated that an electric current of from 600,000 to 1,000,000 volts would be necessary in order to produce Roentgen rays of as great penetration as the most penetrating rays of radium; that is, currents ten times greater than the strongest currents now employed for the Roentgen rays. Previous to the advent of improved Roentgen ray tubes of the Coolidge type, this argument was more convincing than at present. With the penetration of the Roentgen rays completely under one's control, it is reasonable to hope that Roentgen rays can soon be generated having nearly as high a penetration as the gamma rays of radium, and it is certain that Roentgen rays can soon be produced from electrical sources in greater quantity and at less expense than the gamma rays of radium can be obtained. Radium is easier to apply than the other agents.

Discussion -- *Dr. J. F. Schamberg*: "Radium has one distinct advantage over the Roentgen ray — the constancy of the dosage. With radium one knows the exact amount of energy given forth; we secure a constant effect from a certain quantity in a certain time from a certain distance. Despite the various energy-measuring devices that have been used to secure precision of dosage of the Roentgen ray, there is still latitude for error. Radium also has the advantage of simplicity of application and of applicability to certain cavities of the body which are inaccessible to the Roentgen rays. Another advantage is the kindness with which radium burns heal."

Dr. W. A. Pusey: "I think there are certain things that can be done with radium that cannot be or at least have not been duplicated with the Roentgen ray. I have seen many cases of angioma successfully treated with radium that could not be duplicated with the Roentgen ray. As to lesions about the nose and eyes, I do not think such patients can be well treated with the Roentgen rays, lest we set up a severe reaction, while with radium I do not hesitate."

SECTION VI A
OPHTHALMOLOGY

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OPHTHALMOLOGY

Radium for Cataract.

W. S. Franklin and F. C. Cordes, Am. J. Ophth., Ser. 3, 3: 643-647, Sept., 1920.

The authors quote Cohen and Levin's technic: "The purpose of this paper is to describe the technic and give our results in 31 cases. Our method of application differs from the published description and has been the result of gradual development and dosage somewhat arbitrary. In the use of screens and distance we have been guided by the experience of the Department of Dermatology of the University of California."

They are using 9.95 mg. of radium element in the form of radium barium sulphate in a circular gold plated plaque over an area of 50.26 sq. mm. The apparatus consists of a specially designed silver cup to facilitate handling the radium. The bottom of this cup is made of a piece of silver 0.5 mm. thick and screens out practically all but the gamma rays. The cup is embedded in a block of vulcanite, the bottom of which is 0.6 cm. from the silver cup. The vulcanite is used as an easy method of obtaining a certain fixed distance and thus has the advantage over gauze pads. The container is now applied on a lead plate 1 mm. in thickness. This plate is shaped to cover the eyebrows and lashes and extends over the cheek a short distance. Directly under the radium is a hole 8 mm. in diameter (the diameter of the radium plaque). The lead plate acts as an additional safeguard against alopecia of the eyebrows and lashes and gives a convenient method of applying the radium. There is some doubt as to the harm done by secondary rays, which in this apparatus are given off by the lead plate, and to prevent the possibility of injury from these rays, a piece of rubber dam is placed, as an additional safeguard, below the lead plate.

"The patient is placed in the prone position and the lids of the eye under treatment held closed by applying a small strip of surgeons' isinglass plaster. A small gauze sponge is placed on the eye to prevent the apparatus from coming in direct contact with the patient. Over this gauze sponge the radium apparatus is placed and held in position by two tapes and two small pieces of adhesive plaster. The patient is told to fix the ceiling with the uncovered eye, thus bringing the lens of the eye under treatment more directly under the radium. In this method, the radium is about 1.2 cm. from the eye.

"The matter of dosage is rather an uncertain one, varying with each type of radium applicator. A milligram hour is the exposure to 1 mg. of radium for one hour. The term gives a method of dosage for a given plaque of radium if the conditions of screening and distance are included. In most of our cases, we have been giving 10 milligram hours twice a week for 4 weeks and then once weekly until the process is stationary. Following this, one exposure a month is given. Experimentally it has been shown that the normal tissues of the eye are more resistant to the radium than the tissues of the skin, consequently the eyelid gives a valuable indication against an overdosage, as a reaction

would take place in the lid before any injury could be done to the structure of the globe.

"A radium emanation plant has been installed at the University Hospital and we are now using radium emanation in the treatment of a series of cases. The tubes are screened with silver so that the silver cup is omitted in the application; with this exception the method remains the same. The length of exposure varies according to the strength of the tube. The dosage given is equivalent to 10 milligram hours. For example if a tube checks up as equivalent to 20 mg. gamma radiation, the time of exposure would be for half an hour. It is too early as yet to give the results with this method."

Before starting the radium-therapy, the vision and ophthalmoscopic findings were carefully noted. An examination was made monthly and the result recorded. When the vision remained stationary one month an application of 10 milligram hours every four weeks was found to hold the improvement.

The authors' conclusions are:

1. "The application of radium does no injury to the normal structures of the eye.
2. "It apparently has a selective action upon the lens.
3. "Radium improved the vision in 84.3% of our cases.
4. "A consistent and known dosage seems advisable.
5. "Frequent treatments are necessary in the beginning."

The Therapeutic Use of Radium in Diseases of the Eye.

H. H. Janeway, Arch. Ophth., 49: 156, 1920.

Although the Memorial Hospital has been using radium for five years, the eye cases, which have been referred to it for treatment, have been few until the last year or so. The following cases have been treated:

- 7 cases of sarcoma.
- 1 case of old keratitis.
- 6 cases of glioma.
- 3 cases of nevi of the eyelids.
- 12 cases of vernal catarrh.
- 1 case of epibulbar melanosarcoma.
- 2 cases of epithelioma of the scleral conjunctiva.
- 60 cases of epithelioma of the eyelids.

Sarcoma — Of the seven cases of sarcoma, four tumors were intra-orbital sarcomas. The radium treatment was not signally successful. The other three cases were sarcoma in the choroid. From the treatment of these seven cases it may be concluded that radium will produce a temporary improvement, though not a complete retrogression in advanced lesions. This marked susceptibility, which the large recurrent growths have shown, indicates that cures may be expected in some cases, if the recurrences can be treated early. Moreover, an early recurrent growth can be treated more effectively because of its accessibility to the use of buried emanation, a more powerful method of handling it than the surface application alone. Certainly every case operated upon should be given the benefit of one posttherapeutic prophylactic

treatment. As regards the treatment of early sarcoma of the uveal tract the evidence at hand does not support the view that radium should replace enucleation.

In sarcoma of the orbital cavity external to the eyeball radium plays a very much more important rôle. Experience does not support the views that in these growths it will save the eye, yet it encourages the belief that it will save the life of the patient. After a preliminary radium treatment, exenteration should be performed and afterwards a post-operative treatment by unfiltered radium placed by cotton support in the center of the orbital cavity. One thousand mc. hours is not too heavy a dose. A severe reaction may follow but if the growth has not already metastasized the patient's life may be saved.

Keratitis—Radium treatment was not successful.

Glioma—Some authors have reported favorably on the use of radium in glioma, but the author's cases, although improved in some instances, have not been altogether successful.

Nevi of the lids—Excellent results have been obtained in the treatment of nevi of the lids. The red birth-mark has been replaced by a cutaneous surface only slightly paler than the normal skin. The majority of these lesions occur in children and the treatments are best made short. Moreover, the majority of these lesions are superficial and little filtration is needed. The very superficial lesions are treated with filtration of only 0.2 mm. aluminum at a distance of 0.5 cm., giving a dosage of 12 to 15 mc. hrs. per sq. cm. The author recommends for irregularly shaped, larger, superficial nevi the use of applications very carefully shaped to the contour of the lesion, upon which the radium must be uniformly distributed. Deeper nevi may be treated with 0.5 mm. of silver filtration at the same distance from the skin and a dosage of 40 to 60 mc. hrs. per sq. cm. according to the extent of the lesion.

Vernal Catarrh—The treatment of vernal catarrh by radium has been most successful. A single radium application is capable of producing an improvement approaching a cure. Sometimes a second treatment is necessary. Due to inexperience in a few of the earlier cases, a little scarring has been done, but never to a degree which seriously diminished the return of the conjunctiva to its normal function. The method now adopted is the application to the tarsal surface of the conjunctiva of a very thin 0.1 mm. piece of lead cut to accurately fit the tarsus and evenly covered with the active deposit from emanation.

Epithelioma of the Orbital Conjunctiva—In this disease and in epithelioma of the lids radium has also performed an indispensable service. Epitheliomas of the eyelids in which practically no destruction of the lids has been caused, and also in some cases where there has been lid destruction, are best treated by surface application. Such is made more accurately by making first a mold of the diseased area and surrounding tissue of dental modeling compound. The compound is warmed and thus softened. It is then placed over the area mentioned and left to cool and harden. When hard it is removed and the diseased area is outlined upon it. The radium enclosed in $\frac{1}{2}$ mm. silver tubes, one to every sq. cm., is inserted in the mold, which is replaced and left over the growth long enough to administer 60 mc. hours per sq. cm.

A Case of Bilateral Glioma of the Retina Apparently Arrested in the Non-Enucleated Eye by Radium Treatment.

M. J. Schoenberg, Arch. of Ophth., vol. 48, p. 485, 1919.

Axenfeld reported a case of glioma of the retina of both eyes in an 8 months' old baby. The right eye was enucleated; the left eye containing several foci was treated with mesothorium and x-rays with encouraging results.

The author's case was that of a girl of 5; was under observation over 3 years. Since the age of one month mother noticed that "the shine of the pupil of the left eye was different than it ought to be." Examination showed a typical appearance of a glioma of the retina of the left eye which was later enucleated. While on the table the right eye was examined and there was found a sharply circumscribed, grayish white tumor, limited above and below by branches of the retinal artery. It occupied an area a little larger than a quadrant of the eyeground, extending from the margin of the disk nasally and below, towards the periphery, but not reaching it. The area was surrounded on all sides by patches of choroidal atrophy with pigmented borders. There were two small spots of gliomatous degeneration in the central portion of the area. Above, was another small grayish mass occupying an area of about four to six disk diameters.

On April 10, 1916, first radium treatment given by Dr. H. H. Janeway — "Radium emanation 36 mc. with lead filter, applied to the right temple for 4 hours. Sept. 22, 1916, second treatment: 58 mc., filtered through a 4 square cm. lead plaque, held over the eye at a distance of 1 cm. for 8 hours. On June 7, 1918, a third treatment of 209 mc. over the right side of the orbit, kept for 14½ hours, filtered through plaques of lead 2 mm. and silver ½ mm. thick." In June, 1919, the child was in good condition. The opacity in the lens appears slightly more dense. The impression is gained that all that was left of the glioma is a degenerated necrosed mass.

The Action of Radium on Cataracts.

M. Cohen and I. Levin, J. A. M. A., 732, p. 1193, Oct. 18, 1919.

A great many eye conditions such as trachoma, vernal catarrh, and various tumors of the eye-ball and adnexa have been treated with radium without impairing the normal structure of the eyeball or its function. The methods used are very similar to the technic of the deep radium therapy employed in the treatment of malignant tumors and various other conditions.

Radium emits alpha rays, beta rays, and gamma rays. The first two act only as a general caustic on all the tissues found on the surface to which the radium is applied. The hardest beta, and especially the gamma rays, have a selective action which causes their efficacy in the treatment of deep conditions. The selectivity of the rays consists in the fact that they may influence pathologic structures while leaving the neighboring normal tissues practically intact. These gamma rays represent only about one per cent. of the total amount of radiations. Koster employed in his glass tube 2 mg. in gamma radiations; there

were possibly not enough soft radiations to injure the normal tissue; but, he had only an extremely small amount of gamma radiations to do the actual work. In modern technic, 10-20 and more times the amount of radium used by Koster is used. All the irritating soft rays are filtered off and only the selectively acting gamma rays are utilized. The actual technic consisted in covering the radium with brass, photographic paper and gauze, and placing it over the lid. The distance between the radium substance and the eyelid was about 2 cm.; 2 to 3 mm. of brass screening and 2 cm. gauze were used. The exposures lasted from one to two hours and were repeated twice a week during the first five weeks and then once a week. Of twenty-four cases studied, 87.5 per cent. improvement occurred in the first few weeks of treatment; this improvement remained stationary, and there was no retrograde to the original condition in any of these patients. The authors feel that it has been thoroughly established that radium does "no injury to the eye and does produce some, if ever so slight, biologic alteration in the lens."

Dr. Cohen, in the discussion, says: "We know that radium does not injure the capsular epithelium in normal frogs' eyes. As regards affecting the cornea, we believe that, if properly applied to the cornea, radium will produce no ill effects to the structure of the eye."

Leukosarcoma of Iris, Treated by Radium.

S. Gifford, Arch. Ophth., 47:241, 1918.

A case is reported of a man who had a leukosarcoma of the iris. Rather than have the tumor removed or the eye enucleated, he decided to try radium treatment. For ten days he received daily treatment with from 32 to 48 milligrams of radium bromide, each treatment lasting from twenty to thirty-five minutes, the tube being applied to the outer surface of the closed lids in all of the treatments except two. At these two treatments, the tube was held directly across the cornea by conjunctival sutures. The immediate result of this treatment was facial paralysis. This persisted for nearly a year, then gradually disappeared. The tumor diminished somewhat in size, but after the lapse of a month began to grow again. Eventually the eye was enucleated.

The author says, however, that the iris offers very favorable conditions for treatment by radium. The rays reach the growth through the clear cornea almost as if it were on a skin surface, and the results of the treatment are as open to observation. If it is unsuccessful and the growth continues to increase, operation may be resorted to with about as good a chance of success as if it had been done at first. It may be with even a better chance, as even partial sterilization of the tumor cells would lessen the danger of their multiplying if some of them should be forced into the circulation by the operation.

Though the results of such treatment in intraocular tumors have been so far rather meager, some of them seem very positive. It would seem, then, especially in tumors of the iris, that treatment by radium should be seriously considered. Where the growth is not especially rapid, even if it has reached the iris root, such treatment should be

offered to the patient as an alternative to operation, he being observed carefully during each treatment. Where operation is refused, it would seem only just to the patient to advise radium very urgently.

Treatment of Vernal Conjunctivitis with Radium.

W. A. Pusey, J. A. M. A., 71:806, 1918.

In the course of the last fifteen years, the author has treated with Roentgen rays or radium several cases of vernal conjunctivitis. The results with either agent seem to be the same, and the application of the radium to the inner surface of the eyelids is so much less difficult than that of Roentgen rays that in the last few years he has used only radium. Following is the technic to be used:

The lid to be treated is everted and held in the everted position by clamping lightly with lid forceps. The blade next to the eye is of solid heavy metal, so that it prevents the eye itself being reached by an appreciable amount of rays. The outer blade consists of a rim with a large opening which leaves exposed the area of conjunctiva for the application of the radium. In these cases the author has used a flat radium applicator containing in varnish 5 mg. of radium element. This application is of sufficient strength to produce a bright erythema on normal skin by an application of ten minutes through thin rubber cloth. In order to avoid discomfort, the author does not make any pressure in applying the radium to the lid, but passes it back and forth over the lid just short of the point of contact with the surface. He has estimated that in an application applied to the whole palpebral conjunctiva with the applicator moving about, each part of the surface of the conjunctiva gets an exposure of one-third the total application; that is, with an application of thirty minutes, the applicator being moved back and forth, each part of the lid gets an exposure of ten minutes. The author has preferred to make the application in broken doses. He makes an application of five minutes' duration over the whole lid for six successive days, so that in the course of a week the conjunctiva gets thirty minutes of a moving exposure, each part of the lid thus getting ten minutes. This exposure with the author's applicator has not proved sufficient to give any evidence of Roentgen-ray reaction. After such treatment, the patient is usually allowed an interval of several months, depending on the condition of the conjunctivitis. Usually the first series of treatments is followed by distinct improvement. In one successful case, the author gave four series of such exposures in the course of a year without at any time producing an apparent radium reaction in the case, but obtaining a completely successful symptomatic result. The number of cases treated is not sufficient to warrant any dogmatic statements, but all have been cases of severe vernal conjunctivitis, with papillomatous thickening of the conjunctiva, with characteristic grayish pellicle, and with extreme photophobia. They have been of many years' duration, have resisted skilful treatment before, and in the cases in which the author has been able to carry the treatment along as far as he thought necessary, the results have been successful to a noteworthy degree. Some cases have shown symptomatic curves that have now persisted for several years. The results, indeed, have been so gratifying

in these otherwise entirely intractable cases, and the treatment so easy, that the method is worthy of wider application than it has received.

Mesothorium Treatment of Eye Diseases.

N. J. Cuperus, Arch. Ophth., 46: 126, 1917.

In many cases of eye disease where the usual remedies are without avail, treatment with radium and mesothorium is favorable, particularly in chronic blepharitis, chronic inflammations of the conjunctiva, cornea, iris or vitreous. Vision is not improved in old opacities of the cornea, although the opaque areas become less dense. The proper moment at which to begin treatment is the one when nothing further can be accomplished by the usual methods of treatment. One or two treatments with these remedies are sometimes followed by a surprisingly good result. If the keratitis or iritis is acute or painful, treatment with these remedies should be cautiously applied. The author was not able to confirm their analgesic action. Even if the eyes are kept quiet during the treatment, the application of these remedies is sometimes followed by an unpleasant irritation which may last for months, though permanent damage has never been observed.

In the first years, the remedy was exclusively applied in trachoma. Cohn saw results from the application of 1 mg. radium for from ten to fifteen minutes. The granules atrophied and the conjunctiva became smooth. Selenowsky, Darier, Thielemann, Dinger, Kardo-Ssissojew, and later Fortunati observed similar results. At the same time other names appear as opponents to radium treatment. These were Birch-Hirschfeld, Jacoby, Braunstein and Samkowsky. They were not satisfied with the results they obtained, and observed relapses. In 1910 Lawson and Mackenzie Davidson reported on radium treatment in eye diseases, particularly in cases of corneal ulcer, interstitial keratitis, episcleritis, pterygium, conjunctivitis, and macula corneae. The quantity of radium used varied from 5 to 59 mg. and the length of application was five minutes. These authors were satisfied with their results except in the case of macula corneae.

Among the articles which have appeared in recent years, that of Prof. Koster and Dr. Cathis is particularly worthy of attention. The treatment was extended to other cases: iridocyclitis, choroiditis, detachment of the retina, blepharo-conjunctivitis, and favorable results were obtained; 5 mg. of radium were applied. The length of application varied from one-half to one hour, and the remedy was applied as near to the affected eye as possible without directly touching it. The eyelids were held apart by the fingers of the other hand.

Report of a Case of Melanosarcoma of the Orbit, Treated with Radium.

E. B. Heckel, Arch. Ophth., 45: 465, 1916.

A case is reported of a man who had a blind eye which he wanted enucleated because it was becoming painful. Upon enucleation a melanosarcoma of the orbit was found. After the man had worn a pros-

thesis for six months, it had to be removed because the tumor was growing and pushing the prosthesis forward and downward. After radium treatment, the patient did nicely for six months. In short, at intervals of about six months, for over two years, radium treatment was applied to check the growth. The patient's general health, however, is now on a rapid decline.

The value of radium, if used in sufficient amount, in malignant disease of the orbit is, in the opinion of the author, clearly demonstrated by this case. The radium kept this neoplasm of the orbit in absolute abeyance, and the patient in a condition to follow his vocation during a period of two and one-third years.

The author presents the following technique: Make an incision through the skin of the lids about 5 mm. from the free border of the lids, completely encircling the palpebral fissure; then dissect the skin only of the lids to the bony orbital wall; then with an electric-cautery knife, at a cherry-red heat, by repeated punctures directed toward the apex of the orbit and as close to the bony wall as possible, completely sever the cone-shaped orbital content, and then introduce one hundred milligrams of radium element and allow it to remain in place twelve hours, the radium to be introduced again at some future time if necessary or advisable. The author is strongly convinced that one application of one hundred milligrams of radium element is of more value than several applications of a less amount.

Radium-Therapy.

Louis Wickham and Dr. Degrais; Cassell and Co., Ltd., London, N. Y., Toronto and Melbourne, p. 277, 1910.

The authors quote a case of glaucoma in a man treated with radium. The patient reported for treatment in December, 1906. He was completely blind in the left eye and partially so in the right. This eye could distinguish some shadows. The diagnosis was "inoperable glaucoma" of several years' standing.

The treatment commenced Jan. 23, 1907, repeated daily until and including February 5. It consisted in the application of apparatus No. 1, for 20 minutes on each place, with the interposition of a rubber-covered lead sheet, $1\frac{1}{2}$ mm. in thickness. The instrument was applied on the right and left fronto-superciliary region, exactly above the eyeball, and on the temporal region. This rubber-covered lead sheet had been used before only as a protective "caché". The object of directing the rays through the thickness of the sheet was to lessen the total intensity, to avoid surface action, and to act very deeply. In this technic the mistake was made of allowing the secondary rays of Sagnac to act, and there was a slight, very superficial erythema.

The patient seemed improved, but there was a return to his original condition on March 26th. This technic is reported as the first attempt at filtering radium rays through a lead sheet. Before this, since 1905, pads of cotton-wool and aluminum sheets had been used as screens.

Radium Rays and Their Effect on the Normal and Blind Eye.

Greef. *Deut. med. Woch.*, 30:452, March 24, 1904.

In the experiments undertaken, 1 gram of a mixture of barium chloride and radium chloride was used. This contained about 0.02 g. pure radium, and was wrapped in a paper case, and then enclosed in iron for safe transportation.

1. *Experiments upon healthy eyes*—In the dark radium confers upon paper, or upon a barium-platinum-cyanide screen a peculiar phosphorescence which flows brilliantly in absolute darkness. When the radium rays were applied directly to the eye it acquired a peculiar diffused, sea-green appearance which was very intensive. The peculiar color became weaker as the preparation of radium was moved further away from the eye, stronger as it came nearer. The phosphorescence was not caused by the container of the radium salts, since this was leather. Nor was it possible to say that the rays were projected from the eyes, for they did not appear to come from any one definite part of the eye. The placing of non-transparent objects between the rays and the eye, or closing the eyes, did not affect the peculiar light effect. Thus radium rays differ in their effect upon the eye from x-rays in that firstly, the former are perceived by the eye without artificial aid, while it is only possible to perceive x-rays after great precautions have been taken; and secondly, the radium rays must be far stronger inasmuch as they penetrate opaque objects, and are not diminished in strength in the process, whereas x-rays would be absorbed. Parts of freshly excised eyes of cows, such as the cornea, lens, vitreous humor, retina, were exposed to radium rays. Very, very slight signs of phosphorescence were shown.

Experiments on blind eyes—In total blindness in which any of the nerves controlling sight, etc., is destroyed, it is impossible to restore vision. If there is the least perception of light, radium rays will penetrate where light rays would not. The radium rays do not present a sharp image, however; only a diffuse light. Occasionally letters, or other objects constructed out of a barium-platinum-cyanide screen, or of opaque material, and subjected to radium illumination, are perceived. As yet there is no practical use of radium in restoring vision.

SECTION VI B
OTO-RHINO-LARYNGOLOGY

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SECTION VI B

OTO-RHINO-LARYNGOLOGY

Radium Technic in Treating Cancer of the Esophagus. Preliminary Report.

C. W. Hanford, J. A. M. A., 78:10, Jan. 7, 1922.

The task set for radium in malignancy of the esophagus is difficult because one is working in the dark, except for the aid of the fluoroscope which will show the location of the stricture if one exists, but can tell nothing of the thickness of the walls of the canal nor the extent of the lesion. The five requisites mentioned by Mills and Kimbrough for the proper emplacement of radium in the esophagus are considered by the writer in his series of 18 cases. (1) Three methods are commonly employed to determine the location; (a) the fluoroscope after the ingestion of bismuth or barium; (b) sounding with olivary bodies, and (c) esophagoscopy, which is not favored except for the purpose of securing a section for microscopic examination. (2) As a means of effective and nontraumatizing canalization of the stricture, fair sized olivary bodies are passed and in cases of extreme stenosis dilatation is done by means of a device, popularized by Sippy, made of piano wire. (3) For maintaining the radium in contact with the tumor the applicator is left in position the required number of hours and then easily removed by means of the attached strings. (4) The roentgenogram will show clearly the position of the carrier. Six hours after placing carrier, patient should be placed behind the fluoroscope and given a small amount of fluid bismuth, and observations taken to determine if the carrier is still in the right position. (5) The dose selected is 50 mg. and the time of exposure from eight to ten hours. Starting at the lower position, at the end of eight hours the string should be pulled up 1 in., at the end of another eight hours another inch, and so on. The treatment is usually repeated in from three to four weeks.

Conclusions show that advance has been made, for in a disease that was always fatal, a percentage of patients is now saved. Dysphagia is relieved. The majority of patients are benefited, and life is prolonged. Gastrostomy is avoided. A more perfect system of dosage, however, is required.

Atrophy of Lymphatic and Tonsillar Tissue by Radium and X-Ray.

C. Augustus Simpson, Virginia M. Month., 48:473, Nov., 1921.

One of the drawbacks to x-ray treatment of the tonsils is the irritating effect upon the parotid gland. It is only enough to produce a dryness of the mouth and this lasts only two or three days, but it is disagreeable to the patient. It may be avoided by a special technic which the author devised. A flat dermatological 30 mg. double strength radium applicator may be used, covered only with a layer of sterile rubber tissue; by applying this unscreened applicator on the surface of the tonsil and using three points, Hampson x-ray through aluminum externally, a cross-fire of radium and x-rays is so concentrated on the

tonsil itself that other structures of the neck are not affected and the effect upon the tonsil is sure. An applicator specially made (Radium Company of Colorado) is $\frac{3}{4}$ in. long, $\frac{1}{8}$ in. wide, oval shaped, with all corners and angles smoothly polished; it contains 26 mg. of radium, covers a surface of the dimensions mentioned, and is stronger than the double-strength square skin applicator. The radium is on the surface of the metal capsule, having no aluminum to cover it and filter out the valuable beta ray. All of the more valuable beta rays are available. This applicator is the strongest made and the effects of the rays are immediate and marked. From cases in which the technic has been tested, and from six years' experience in atrophying the thymus gland with x-ray, the author is positive that he can cause complete atrophy and disappearance of any tonsil in from one to three treatments. Eliminating any suffering, hemorrhage and anesthetic, it should be a valuable method, especially in cases in which surgery is contra-indicated.

Case of Intranasal Epithelioma Cured by Excision and Radium Literature.

Dunbar Roy, Ann. Otol., Rhinol. and Laryngol., 30:748, Sept., 1921.

The patient came on account of soreness and closure of the left nasal cavity which had been present for several months. This was accompanied by a scabby condition and occasional bloody discharge. Just within the left nasal cavity could be seen a small growth at the anterior end of the inferior turbinate, close to the mucocutaneous margin, dry and about the size of a bean, slightly scabby, sessile in form, with tendency to bleed if touched. It looked like a fibrous papilloma and was easily removed with cold wire snare and but very little hemorrhage. Pathological report described it as a basal cell epithelioma. Four weeks later there was considerable irritation inside the nose, accompanied by scabbing and bleeding and the patient was referred for radium treatment. Nineteen months later there has been no return of the trouble. Contrary to the opinion of several observers, the writer's experience leads him to conclude that radium is much more effective in epithelioma than in other forms of malignant growths. He believes that in massive tumors of the sinuses radium without operation is useless. However, thorough operation combined with immediate radiation through a wide opening in the face, which for purposes of observation is allowed to remain permanently, will give better results than we have been accustomed to consider possible.

Radium in the Treatment of Epithelioma of the Lip.

Douglas Quick, J. Radiol., 2:1, Dec., 1921.

Quick, speaking for the Memorial Hospital, states that the primary lesion in epithelioma of the lip should be treated entirely by radium. In the more deeply infiltrating lesions this should be supplemented by the use of radium emanation imbedded interstitially. For the treatment of primary tumors a mould of dental modeling compound is made to

fit the lesion and silver tubes, the walls 0.5 mm. thick, containing radium emanation are sunk into this mould to a depth of 4 mm. The tubes are so arranged that one is available for each square centimeter of surface to be covered. For lesions of ordinary size, the dose given is 60 to 65 millicurie hours per square centimeter of surface. The tubes must extend well beyond the limits of the growth in all directions. In the average case this surface radiation is sufficient; but, for the treatment of deeply infiltrating growths, it is supplemented by burying small glass capillary tubes of radium emanation in the substance, by means of fine trocar needles, and leaving them in situ. The total radiation from 1 millicurie of emanation is equal to about 132 millicurie hours. In all cases the cervical nodes, whether palpable or not, are treated with either radium or x-ray externally. Following this, cases without palpable nodes are kept under observation. If nodes are involved, or become involved, a complete unilateral neck dissection under local anesthesia is done and radium emanation in very weak tubes is buried throughout the wound. Dissection of the opposite side may be done subsequently if indicated by the presence of nodes. External radiation following operation is advisable in the majority of cases.

While too little time has elapsed to permit of comparison with surgical statistics, experience at the Memorial in unselected cases indicates that radium deserves the foremost place in the treatment of lip cancer, and, if properly applied, will produce results surpassing the present surgical statistics with a minimum of sacrifice on the part of the patient. The resultant scar is in most instances scarcely discernable. Of 115 cases treated during the last four and one-half years, which could be traced, 80, or 69.5%, are free from disease; and of these 16 are over three years' duration, and 4 over four years. Twenty-seven of the patients have died, and 8 are becoming steadily worse. Of 92 primary cases without palpable nodes at the time of admission, 67, or 72.8%, are known to be clinically free from the disease. Two of the patients died of intercurrent disease and another of apoplexy, although clinically free from carcinoma. The remainder could not be traced.

Malignant Neoplasms of the Upper Respiratory Tract and Radium Therapy.

Paul Delobel, J. d. sc. méd. de Lille, 39:265, Oct. 23, 1921.

The author treated the following cases with radium: (1) Vegetating epithelioma of the left nasal fossa, in a woman of 46, the nature of which was confirmed by histological examination; 200 mgm. of radium applied during thirty-six hours. Three months later the nasal obstruction and pains had disappeared but the opacity of the maxillary sinus persisted. (2) Epithelioma of the larynx in a man of 40. The appearance of this was very similar to a tuberculous ulcerative and infiltrating lesion. The patient had been previously tracheotomized, so radium was introduced through the wound and left thirty-six hours in the larynx. The condition of the patient remained stationary after three months and a marked regression of an indurated glandular mass, which had at first increased, was obtained following x-ray treatment.

(3) A vegetating epithelioma of the larynx in a man 68 years old. Histological examination showed the tumor to be an epithelioma with epidermic pearls. Tracheotomy was rendered necessary by the asphyxiated condition of the patient and several days later, the author introduced the radium through an opening made in the thyroid cartilage, as retrograde catheterization of the trachea had proved impossible. Three months later the larynx was still congested but no traces of vegetations could be seen on the vocal cords.

Without entering upon a consideration of ultimate results, the author calls attention to the simplicity of radium therapy, whereby grave, painful and mutilating operations are avoided. Rubber sounds containing radium are used by Delobel for the applications. For the nose, the sound is introduced carefully into the diseased nasal fossa and kept in position by adhesive plaster. For the larynx, radium tubes are placed on top of each other in the sound, so as to reach a height corresponding to the length of the larynx (3.5 cm.). The sound is pushed through the tracheotomy opening and caught in the mouth with clamps. Another sound, which is passed through one of the nasal fossae, is used to draw the first through the anterior naris, care being taken to have the radium-bearing portion of the sound at the level of the larynx. This technic may be applied to ulcerative cancerous lesions. Two failures in vegetating cancers are recorded. Delobel hopes to avoid thyrotomy through the use of a semi-flexible, blunt, metallic catheter.

Squamous Cell Carcinoma of the Antrum. Report of a Case Treated with Radium Alone That Is Free from Recurrence Twenty-Two Months After the Last Application.

J. Harper Blaisdell, Boston M. and S. J., 185: 570, Nov. 10, 1921.

A statistical comparison in methods of treatment by operation, by combined cautery and radium, and by radium alone. For the results by operation, Blaisdell quotes Davis's "Malignant Growths of the Upper Jaw and Antrum," a report of 39 cases in the Charing Cross Hospital, London. Of these 39 cases, 19 were cases of squamous cell carcinoma, 5 of which were considered inoperable because of extent of the cancerous process; of the remaining cases operated upon, that could be traced, the cancer returned in 6 within the following year; only 3 of the 19 cases were free from recurrence for periods of twelve months to two and a half years.

For the results from treatment combining cautery and radium, Blaisdell refers to New's "Treatment of Malignant Tumors of the Antrum." According to New, the Mayo Clinic has abandoned removal in favor of combining cautery and radium. A series of 33 cases covering a period of three years is reported. Of these, nearly 50% were considered untreatable because of extent of the process; 19 cases of this group were squamous cell carcinoma, and 11 of the inoperable were among this group. In this series there was no operative mortality and no postoperative chest complications; in 2 cases where the floor of the antrum was involved, the eye on the affected side was lost from reaction to cautery and radium. Final results of this series, from a period of

twelve to twenty-seven months after treatment, show 2 deaths, 2 recurrences, 1 without data, and 3 non-recurrences.

For the results of treatment by radium alone, Blaisdell details the case of 1 of his patients, a man 63 years old, with squamous cell carcinoma due to a gauze dressing left in a tooth socket by a dentist. This patient came for treatment two years after the original tooth trouble, and six months after symptoms referable to the antrum had appeared. There was an immediate excellent effect after the first treatment, but second treatment was followed by a period of three months of extreme suffering, due to necrotic processes. During this period the constitutional effect upon the patient was most striking; it is described as a mental dulling and complete physical failing; appetite failed, weight fell from 180 to 130 pounds; memory failed, the mind became childish; pain was so extreme as to require morphin for several weeks, and the patient was confined to bed for the last month of this period. The eye on the involved side was not affected, however, at any time. Fatal termination seemed the only possible outcome. But a large mass of sequestrum came away one morning, the patient got out of bed the same day, and his appetite came back immediately. The final result was complete removal of the antrum and its surrounding structures from the mouth to the orbit. Normal tissue healed readily; no further treatment or procedure has been necessary. Within a comparatively few weeks the patient returned to his work, as vigorous as he had been all his life; his weight returned to 185 pounds. His speech is thick and difficult to understand, and he has some trouble in eating, but he declines any prosthetic device to help this condition, at present. No recurrence has appeared in the twenty-two months that have elapsed since the second treatment.

A Device for Radium Treatment of Malignant Tumors of the Jaws.

J. Bercher, Paris méd., 11:205, Sept. 3, 1921.

In the treatment of tumors with radium, the radium element can be brought into contact with the malignant tissues either by means of platinum needles embedded in the tumor, or by means of radium tubes. The radium tubes must be kept in contact with the tumor for a considerable period, often as long as eight days. A support for them must be constructed that may be easily borne by the patient and will not interfere with the action of the radium. Metal must not be used. Vulcanized rubber is the best material. An impression or plate is made of the maxillary region where the tumor is situated, the teeth in this region having been extracted; on this model, a rubber plate is constructed at least 2 cm. thick in the region of the tumor, and small openings are made in which the radium tubes can be placed, of sufficient depth so that the radiation will be homogenous, the tubes not being in direct contact with the tumor, but at a definite distance from it, while the surrounding tissues are protected from the action of the radium by the rubber. When the tubes are in place, it is fixed in the mouth and covered with paraffin or wax. If it cannot be held in place without metal clasps, these must be placed as far as possible from the radium.

It should be worn night and day, but may be removed at meal times as it interferes with mastication. The construction of this rubber plate varies in each case with the site of the tumor, the shape of the jaw, and the condition of the surrounding tissues. This may often tax the ingenuity of the stomatologist: In some cases where, owing to previous operation or radium treatment, there is considerable scarring and sclerosis in the region of the tumor, surgical débridement may be necessary to make free access to the tumor possible.

Treatment of Hypertrophied Tonsils and Adenoids by Radium, a Preliminary Statement.

F. H. Williams, Boston M. and S. J., 184: 256, March 10, 1921.

The author criticizes Witherbee's method of using Roentgen rays to treat the tonsils from "under the angle of the jaw" and the adenoids "through the back of the neck" because of the danger of exposing other parts to the action of the rays, as the lymphoid tissue. When radium is used the maximum radiation reaches the tonsils and adenoids; also the output is constant and the dosage can be exact.

Use 50 mg. bromide of radium in a flat container, with the rays filtered by 0.83 mm. of aluminum, held directly against or near the tonsil. Withdraw the radium every few minutes, or as often as it is comfortable for the patient, until the total exposure of fifteen minutes, more or less as required, has been reached. Improvement is immediate but the ultimate results may be expected only after some weeks. Two or three treatments at intervals seem to be more satisfactory than one.

The author has devised a container to be held midway between the tonsils. It consists "of a disk of lead (not more than 2 cm. in diameter and about 1 cm. thick, more so in the middle) with a hole bored through its center, somewhat flared at each end, for the exit of the ray, and another bored from the outer edge radially to a little beyond the center. The tube containing the radium may be slipped into this and the opening afterwards closed by screwing a metal handle part way into it. The uvula, the back of the throat and the parts behind it are thus protected by about 1 cm. of lead. When treating one tonsil only, the opening towards the other may be closed by a plug of lead. Appropriate filters should be used."

Another instrument, shown in a sketch, consists of a small bulb at the end of the bent portion of a glass tube, for the radium. The straight end is inserted into a metal handle about 30 cm. long. The radium is kept in position in the bulb by stuffing the tube with spun glass, and more spun glass is pushed in until the tube is nearly filled, the end being closed with a cork. An aluminum filter cap is slipped over the bulb and then the bulb and bent portion of the tube are enclosed in sheet lead, except the lower end of the bulb. The lead should extend more or less beyond the bulb according to the area to be treated.

"Before applying the radium, the throat should be moistened with a suitable solution of cocaine to prevent gagging. . . . All instruments should be covered with two thicknesses of rubber, and for this purpose two rubber finger cots are stretched over them and far down on the handle, where they may be secured by a strip of plaster."

Radium in the Treatment of Malignant Tumors of the Nose and Throat. Its Use and Possible Abuse.

R. Sonnenschein, J. A. M. A., 75:860, Sept. 25, 1920.

Radium: Indications for use: (1) When surgery is impossible or impracticable; (2) combined with surgery when complete removal is impossible; (3) in inoperable cases to relieve pain, hemorrhage, odor, discharge, sepsis.

Action on various types of tumors: (1) Favorable influence on round cell sarcomas or lympho-sarcomas; (2) less effective on squamous cell carcinomas; (3) practically ineffective on epitheliomas containing epithelial pearls, and on carcinomatous glands.

Comparison with Roentgen Rays: (1) Beta and gamma rays of radium have greater penetrative power than any of the Roentgen rays; (2) radium destroys cancer cells at a distance of only 2.5 to 4 cm. from tube, but this action can be increased by cross-firing; (3) radium produces a greater degree of reaction without permanently injuring the healthy tissue.

Advantages: (1) Small, portable, easily handled applicators; no appreciable depreciation; (2) no danger of high tension electric shocks; (3) easy application to inside of tumors without destruction of intervening tissues; to inside of cavities like larynx, pharynx, etc.; (4) produces painless coagulation and necrosis; (5) effect easily confined to small areas.

Disadvantages: (1) Requires longer exposure, on the average four hours per area; (2) burns are usually unimportant, but if occurring in the larynx they may cause gangrene; (3) large doses of radium may cause toxemia, due to escaped radiation and affecting bone marrow, liver, or other organs.

Therapeutic effect: Depends on (1) amounts of radium used; 80-100 mg. kill cancer cells in seven hours; (2) length of exposure; short for superficial effects; longer for deep effects; (3) distance of application; (4) filtration; silver and lead have equal powers of obstructing rays; platinum has twice their absorptive action; air space prevents radiations of certain length from passing; rubber tubing 0.25-4 mm. thick cuts off the secondary rays from the filters; filters must be of definite thickness depending on quantity of radium and type of tissue treated.

The Use of Radium in Carcinoma of the Face, Jaws and Oral Cavity.

E. Fischel, J. Missouri M. Assoc., 17, No. 7:267-269, Chicago, July, 1920.

Introduction:

1. Material for this article has been collected from Barnard Free Skin and Cancer Hospital; cases were selected to demonstrate useful application of radium.

2. Cases are submitted to conference of entire staff; method of treatment is decided by confreres; extent and nature of operation is left to surgeon's judgment.

3. Hospital has acquired 100 mg. of radium in tubes; a 10 mg. plaque; a 10 mg. needle; radium tubes have been the routine treatment; use of radium plaque has been restricted to superficial basal cell growths.

Types of carcinoma:

1. Majority of basal cell epithelioma yield to any method of treatment; x-ray will cure nearly 100 per cent; basal cell can usually be clinically differentiated from other types.

2. Some squamous cell carcinomata have low malignancy and are readily destroyed; comparative malignancy may be determined by rapidity of tumor growth.

3. Most prickle cell carcinomata are very resistant; readily extend beyond visible or palpable limits of the disease; comparative malignancy may be determined by rapidity of tumor growth; this type is commonly found about face, jaw, oral cavity.

Methods of treatment:

1. Recognized treatments of carcinoma are surgical removal; actual cautery; destruction by x-ray, radium or high frequency current.

2. *Surgical* removal gives quickest results with least disability to patient; danger factors are nervous shock, traumatic shock, hemorrhage, anesthesia; ideal surgical primary operation removes tumor together with lymph glands, lymph channels, normal tissue surrounding the tumor; this type of operation now physiologically possible in carcinoma of lower lips, tongue, floor of mouth, breast, uterus, penis, upper and lower extremities.

3. *High frequency current* and actual *cautery* positively act on tumor without opening fresh blood and lymph channels; healing is a slow process because the devitalized tissue must slough before repair can begin.

4. *X-ray* treatment cures nearly 100 per cent of all cases of basal cell facial epitheliomata; so far it cannot be relied upon to destroy even superficially the more malignant types of tumors.

5. *Radium* treatment least upsets routine life of patient; maximum dose can be directed over an absolutely exact area; will destroy growths of considerable depth and extent with a minimum of scar formation; radium can be buried in the tumor mass itself and is therefore of great value as an adjunct to surgery in otherwise inaccessible tumors; initial dose should be the maximum one needed for complete destruction of carcinoma; persistent use of radiation after growth has failed to respond favorably should be condemned.

Results of radium treatment in:

1. Carcinomatous facial ulcers—radium can be relied upon to heal these.

2. Carcinoma of eyelids—radium is most efficient method of treatment; does not damage globe, vision or distort eyelid.

3. Carcinoma of lower lip—radium has replaced surgical treatment; in primary lesion radium should be used in large unscreened dosage; technique at clinic is that: if glands are palpable wait three months after first radiation before removing submental and submaxil-

lary lymphatic system; if submental glands are palpable wait six weeks after first radiation before resecting glands; if submaxillary glands are involved radiate lip and perform Stewart type of operation within one week and later remove all superficial and deep lymphatic tissue of both sides of neck.

4. Carcinoma of jaw, oral and buccal cavities—radium has a limited use only; reason for lack of success is probably a purely technical one; difficult to maintain surface applicators in one position within the mouth; difficult to have soft parts remain steadily opposed to applicator; carcinoma involving bones of upper or lower jaws should be surgically removed and remnants of the growth destroyed by supplemental use of radium; 1 case of inoperable carcinoma of lip, tongue and floor of mouth became operable from the use of radium; 1 case of extensive carcinoma of the antrum remained well fifteen months after operation supplemented by radium treatment of apex of antrum.

5. Leukoplakia—radium is the only efficient treatment of leukoplakia just changing into malignancy.

6. Verucca-like epithelioma of buccal mucous membrane and alveolar process—radium acts like magic.

Malignancies of the Mouth and Neck.

E. H. Skinner, Nebr. State M. J., 5, No. 7: 194-197, Norfolk, Neb., July, 1920.

Radio technique:

1. In the orifices, sinuses and upon all mucous membranes radium is more reliable than x-rays; its radius of activity rarely exceeds 2 cm.

2. Radium without sufficient filtration gives immediate superficial effect with sufficient filtration and distance it gives the deeper effects.

3. Radio-toleration of skin may be increased by alkaline washes and sun baths.

4. Radio-toleration of patient may be increased by alkalization with soda bicarbonate, potassium citrate, potassium bitartrate, milk of magnesia, Kalax water, magnesium sulphate by mouth or enema, combined urotropine and salol medication.

5. General strength of patient may be saved and period of irradiation shortened by electro-coagulation and surgery.

6. Radio-therapy requires six times the filtered x-ray dosage that the skin will tolerate in order to produce an erythema dose 7.5 to 10 cm. deep; cross-firing through six skin fields is essential for proper irradiation of every deep area.

7. In glandular metastasis and prophylactic irradiation it is necessary to give huge x-ray dosage of high spark gap, with ample protection filtration and cross-fire through multiple fields of entry.

8. Radio-therapy is successfully completed only when coarse hair disappears and skin tans under exposures with total tolerance of time.

Radio-therapy in:

1. Leukoplakia—Abbe, the pioneer radiotherapist, stated (1913) that radium is the only curative treatment; it is the specific treatment

and quickly controls leukoplakia; can be applied upon dental-rubber-impression-compound to any part of mouth; dosage varies with depth of lesion; violent reaction necessary to hasten results.

2. Lymphosarcoma—radium is almost a specific in these cases; both radium and x-ray treatment given every three weeks; growth usually reduces 60 per cent. within three weeks, vanishes within two months; permanent results obtained only with prolonged treatment; prolonged post operative radiotherapy is essential to prevent recurrence.

3. Epulis—near-sarcomas of alveolar portions of superior and inferior maxillae; may be removed by surgery or actual cautery; post-operative radio-therapy guards against recurrence; may be limited to original site of tumor since there is no glandular metastasis in this condition.

4. Osteo-sarcomas—radiotherapy may be used as primary treatment with good results; may be combined with surgery and actual cautery in removing sarcomas of the maxilla and antrum; reports 1 case of sarcoma of right eye and right maxillary sinus with recurrence after two operations, treated with 50 mg. radium tube inserted in antrum, remarkable recession after two weeks, reduction to normal after six weeks, case remained well for six months, prophylactic raying of glands and antrum continued; reports 1 case of malignant antral sarcoma with glandular metastasis in neck, treated postoperatively with x-ray, metastasis checked and gradually reduced, treatment continued for eight months, condition favorable.

5. Osteo-chondroma—reports three cases, all completely relieved by radiotherapy, oldest case cured five years ago after four successive series of exposures, 2 cases operated twice for recurrences; osteo-chondroma apt to recur unless vigilant raying is maintained for at least six months, all signs of recurrence have disappeared; immediate prolonged postoperative radiotherapy insures best results.

6. Tonsillar cancer—radium relieves odor, discomfort and major portion of pain; radium may be directly inserted into cancerous growth and enlarged neck glands; no cures have been achieved in 3 cases of inoperable tonsillar cancer; treatment reduced tissues and checked growth in 1 case still alive two years after treatment.

7. Cancer of the tongue—radium relieves pain and odor in inoperable cases; danger lies in overtreating with radium and obtaining disagreeable reactions; radium treatment should be supplemented by prophylactic medication, such as a mouth wash of potassium chlorate, morphine, atropin, papine to relieve pain, tannic acid as astringent, soda bicarbonate as a packing; early lesions can be managed with radium treatment of lesion and deep x-ray blocking to lymphatics of the neck down to the trachea to complete operation of mouth carcinoma.

8. Cancer of the lip—block dissection including the lowest glands essential to successful operation; deep intensive radiation destroys activity of lymph glands, shrivels and fibroses them; radium should be applied to actual lesion; x-ray deep therapy to tributary neck glands for several months after operation; denser lesion responds more promptly to radium; softer lesions like epuli, papillomata, sarcomatous detritus, dirty ulcer bases, should be eradicated by surgery or diathermy before applying radiotherapy.

Some Considerations upon the Present Status of the Etiology and Treatment of Cancer, with a Report of Four Cases of Cancer of the Larynx Successfully Treated with Radium.

D. B. Delavan, Tr. Am. Laryngol. Ass., 41: 131-137, 1919.

The permanent effects of surgical treatment of laryngeal cancer are little known as accurate statistics have never been compiled. Use of radium and x-ray deserves most attention among methods of local treatment. Four cases are outlined.

No. 1: U. S. carcinoma of larynx; distinct swelling over left arytenoid and some over right. Appearance simulated tubercular laryngitis, mucus being gray and subjacent tissue edematous. No evidence of tuberculosis was found in the lungs, sputum or secretion from the larynx. Later a superficial growth developed in the larynx which was removed under suspension laryngoscopy. The growth redeveloped and on March 24, 1917, radium was applied as follows: 4 x 25 mc. platinum filter, 1 mm. rubber tube inserted in larynx for 2 hours. On June 7 complete laryngectomy was performed. Recovery was excellent and the voice is clear. Patient still wears a tracheotomy tube.

No. 2: Extensive carcinoma of interior of larynx. Radium was applied in August, 1918, as in No. 1. Radical extirpation of larynx followed in Jan., 1919. By the following June a small enlargement in the external scar. This is subsiding under radium treatment. Development of speech is slow but satisfactory.

No. 3: U. S. laryngeal carcinoma. Two-thirds of the interior of the larynx, the left side of the base of the tongue, and left lateral wall of the pharynx were involved. The lumen of the larynx was practically obliterated and dyspnoea urgent. Tracheotomy was performed in Jan., 1918. Because of extent of growth and advanced age of patient, radical operation was not advised. After a temporary arrest, the disease reasserted itself and was treated as follows: May 23, three tubes, 9.8 mc., were embedded in the growth for 132 hours: June 26, one tube, 4.9 mc., was embedded for same length of time. Ten days later there was still edema in the treated area. On July 12, pack treatment was applied and on July 21, radium treatment was resumed, a pack being placed over the left side of the neck, 1222 mc. for 40 hours. July 27, pack over right side, 1456 mc. for 5½ hours. Marked improvement. March 1, 1919, under chloroform, tracheotomy tube, a foreign body and several small masses of redundant tissue were removed, after which tube was reinserted. Patient still under observation although all activity seems to have ceased.

No. 4: Epithelioma left vocal band. Voice hoarse, excessive tobacco smoker. Surface of vocal cord destroyed by ulcerated tumor but infiltration was slight. Sept., 1918, 880 mc. filtered through 2 mm. lead was applied externally on each side over larynx at a distance of 5 cm. from the skin for 5¾ hours. Complete retrogression followed and the only evidence seems to be some cicatricial tissue which causes hoarseness.

Treatment of Laryngeal Neoplasms with Radium.

L. Barajas, *Med. Ibero.*, 1919, *Numero extraor.* 1, *Cong. nac. de med. y cirug.*, page 101.

As they are still uncertain the results of the use of radium in laryngology are at present being carefully watched.

The radium should be placed in the larynx *in situ*, using the gamma rays and avoiding the stimulation of the secondary rays. Cases of spreading epithelial tumors evidently undergo a process of amelioration, even to an apparent cure, after the first applications of radium if the dosage is adapted to the case and the subject. In all cases observed by the author, however, the tumors reappeared in a very short time, and in 58 cases not one complete cure was obtained.

Radium exerts a positive retarding action in the growth of neoplasms, in some instances causing an encysted lardaceous degeneration. Its analgesic action in moderate doses is evident and constitutes one of its most important benefits. The use of radium does not change the indications for operation which is the best treatment, but is valuable for patients who refuse operation. It is not known to what extent postoperative applications influenced recurrences because those in whom recurrence has begun go on in the same way in spite of the radiation, and when there is no recurrence we cannot be sure whether this condition is due to successful surgery, or to the radiation.

The author found that the dosage should not be less than 45 or 50 milligrams, not more than 75 or 80 milligrams, with a maximum duration of 2 hours each application, which should be made as frequently as the reaction of the organism after treatment will permit. The greater the amount of radium used and the longer the time of application, the more rapid and intense the reaction.

The use of radium in hemorrhagic forms of neoplasms is not recommended, as it increases the hemorrhage both from the neoplasms and the surrounding tissues.

The pavement-celled epithelioma is the most refractory to radiotherapy and its exacerbations most evident, but the beneficial effects of radium are very evident in papillomata, absolute cure having occurred in cases of multiple recurrent tumors of this type. In ulcerative tuberculosis radium is completely contraindicated, while in lupus its benefit is positive.

The author is satisfied that radium merely retards the development of some varieties of epitheliomata, hastens it in others, and completely cures none, but that it greatly decreases the pain.

Radium Treatment of Cancer of the Tonsils.

M. Lannois and Moutet, *Lyon Méd.* 126: 495, 1917.

The authors report the present condition of patients given radium treatment a year or more ago. One young man has nothing left of his tonsils, and the enlarged glands in the neck and axillae have subsided to normal size and shape. He has been an active wage earner during the year since, but recently some enlarged glands were palpated in the inguinal region. They do not seem to be metastases but a new manifestation of the lymphadenia to which he is subject.

Two other patients are at work with no indication of recurrence.

In a fourth case, a woman of 74 was treated for a lymphosarcoma in the left tonsil. A needle with stout thread was passed through the anterior pillar and the platinum tube containing 48 mg. of radium was drawn by the thread into the depth of the tonsil, a hole being burrowed for each end of the tube in the abnormal tonsil tissue. A small tampon of gauze was placed over it and the tube was left in place for nineteen hours. The dose applied was 912 milligram hours. Improvement was rapid, the tumor promptly subsiding, and in a month or two both tonsils had completely retrogressed.

In another case the cancer in the tonsil was far advanced but the symptoms were notably improved by implanting the radium tube in a slit made with the bistoury in the tumefied tonsil. It was left in place for twenty-four hours, and the condition was much relieved. The application was repeated later, and swallowing became less difficult but the enlarged glands in the neck were not modified. The man is now taking a course of Roentgen treatment for them, but his condition is precarious.

Angioma of the Larynx.

G. Sterling Ryerson, Canad. Med. Assn. Jour., 2: 111-113, 1912.

Angioma of the larynx, up to the time of writing this article, seems to have been a rare affection, but few cases having been reported in the literature.

Histologically, the cavernated tissue in angioma is lined with a single layer of epitheloid cells. The vascular spaces may be empty or filled with laminated clots. The surface partakes of the epithelium of the part. The stroma may undergo mucoid degeneration, giving the growth a mixed character.

Angioma cavernosa presents the appearance of a raspberry-like mass and may be either sessile or pedunculated. It may appear in any part of the larynx, but is most common on the vocal cords.

As a review of the literature revealed the disastrous results of treatment often occurring from galvanocautery or crushing with forceps, Ryerson decided to use radium. This was done with success in the writer's case.

Case. Woman, single, age 55 years. Patient complained of difficulty and oppression of breathing at times, but no pain, hoarseness or cough. No family history or growth of tumors. Patient's mother had "thick neck" and died of heart failure at an advanced age. Present difficulty began about a year previous to present examination (May, 1909), with stiffness and pain in the tongue and occasional difficulty in breathing. Patient said that some enlarged veins at back of tongue had been burnt off. No difficulty in swallowing. Examination of the larynx showed on the left side of the anterior surface of the arytenoid, on the ventricular band and along the external margin of the vocal cord, a bluish-purple mass lobulated, and presenting the appearance of a small raspberry. On the anterior surface of the right arytenoid was another similar body, but smaller, which extended beyond the arytenoid. Patient had a small goiter.

Regarding the treatment by radium the writer says: "In view of the disastrous effects of operative interference, I determined to try radium, and obtained from Dr. E. E. King a tube of German radium of unknown activity.

"With Dr. King's assistance an applicator was devised and treatment begun. Meanwhile, I communicated with Dr. Wickham in Paris, who advised a special applicator furnished with three mg. radium, activity 1,000,000. This was obtained in due course and treatments continued at intervals of three months, for a year. At the end of that time there was a considerable improvement, but much of the mass still remained. I then obtained a small disc containing 10 mg. of radium, activity 500,000, and had an applicator made so that it could be introduced into the larynx. I continued the treatment with the former intervals, when a marked improvement was soon noticeable. By April, 1911, it had disappeared, except a small point which I thought I could venture to cauterize with electro-cautery without danger. I did so, and today where formerly there were two vascular growths there are two small cicatricial nodules."

This was Ryerson's first experience with radium treatment. He believes that had he had the requisite appliances when starting the treatment, combined with experience since gained with this form of treatment, the cure would have been accomplished in half the time. One of the difficulties encountered was the impossibility of retaining the applicator in place longer than from one to three minutes at a time, in spite of liberal cocaineization.

The writer does not believe that the goiter bore any direct relation to the throat lesion. The difficulty in breathing may be due to a possible edema of the larynx, which has been said to accompany the condition of angioma of the larynx.

Angioma and nevi, in the writer's opinion, resist radium in direct ratio with the age of the patient—the older the subject, the greater the resistance. This applies to the mucous membrane as well as the skin.

SECTION VII

RADIUM—ITS EFFECT UPON THE BLOOD AND
USE IN BLOOD DISEASES

United States Radium Corporation
New York

SECTION VII

RADIUM—ITS EFFECT UPON THE BLOOD AND USE IN BLOOD DISEASES

The Influence of Radioactivity in the Treatment of Hypertension.

C. E. Field, Med. Rec., 98: 1051, Dec. 25, 1920.

The author states, "Observing carefully our clinical results, together with conservative deductions made from our laboratory findings, we do not hesitate in placing radium in the very forefront of therapeutic measures for the relief of hypertension."

Administration: Radium may be administered by means of emanation inhalation, radioactive waters for drinking, solutions of radium salts for drinking, by means of emanation baths, or by intravenous or subcutaneous administration of radium bromide or radium chloride. Wherever dosage in micrograms of radium salts is quoted, it refers to *radium element*. Radium has absolutely no toxic effects, it being accepted as harmoniously by the human system as is sunlight by the plant.

Most interesting research is now being made in measuring the radioactive content of the blood for weeks following treatment. The activity of radioactive waters is of short duration and consequently they are limited in their application. It is probable that no emanation can be traced two hours after taking, whereas radium solution by mouth can be traced and measured up to the sixth day. Following an intravenous injection of radium chloride, it can be traced in the blood at least twelve weeks thereafter.

"So far as dosage is concerned in high blood pressure, we are largely governed by the chronicity of the case and the involvement. Personally, I feel my best results have been shown in what we would term low dosage."

It is the author's usual plan to give an injection of one 25 micrograms (radium chloride) ampule (2 c.c. normal saline solution), and following with solution of distilled water, two ounces, containing 2 micrograms of radium chloride given by mouth as one dose three times a week. After four weeks this drinking solution is cut to two doses per week. While the results are prompt, the author never accepts a case for less than twelve to sixteen weeks treatment and observation. Careful record of the laboratory findings are always to be made.

Where radium solutions by mouth alone are given, the author's dosage starts at 6 micrograms per day in three doses; this to continue for four weeks as a rule, then to follow at 6 micrograms per week for the balance of the course. This plan of treatment does not give as uniformly good results as a course inaugurated with an intravenous injection. The plan of insisting on the long time treatment was arrived at, owing to the fact that after the initial drop in pressure, or within five days, the patients generally felt so much improved that there was a tendency to discontinue treatment. It was necessary to make it clear that the early relief had nothing to do with the permanency of the effect most to be desired.

As to the permanency of this treatment the author states "that fully three-quarters of the cases have held without further treatment

for from six to twelve months. There are many of the early cases treated nearly four years ago that have suffered no material rise. Others where pressure has gone up sufficiently to produce symptoms have been quickly touched up with a two or three weeks' treatment. Some of these returned with their trouble on account of growing bold with their diet." An interesting feature in the author's cases has been an activation of sexual powers. Insomnia and nervous symptoms are improved and the patients invariably take on a feeling of well being.

"Compensatory functions can be sustained and greatly improved at times with extremely low dosage of radium. In such cases we may observe both systolic and diastolic pressures slowly coming down in a fairly even proportion. Although I can find no record of any unfavorable action following the administration of the soluble salts of radium, I would urge caution in attempting sudden reductions in compensatory high pressures. Here must come a full understanding as to the type of compensation."

The Blood Cholesterol in Malignant Disease and the Effect of Radium on the Blood Cholesterol.

G. Luden, J. Lab. & Clin. Med., 4: 849, 1918.

"Aside from the effect of radium on metabolic processes and thereby indirectly on the composition of the blood, the following considerations may help account for the reduction of the blood cholesterol (Bloor I) following radium treatment. Schulze and Winterstein have shown that cholesterol is oxidized and disintegrated by the action of light. It is known that radium is photoactive. It is possible, therefore, that the photochemical activity of radium may cause the changes observed in the cholesterol content of the blood after radium treatment. The increase of the cholesterol split products in the blood, namely, the increased difference between Bloor I and II, supports this interpretation.

"If we compare the disintegration of cholesterol in the body to the combustion of fuel by fire, changed or oxidized cholesterol may be compared to fuel that has been consumed and thus rendered harmless, whereas pure, unchanged cholesterol may be compared to fuel that has not yet been consumed. An accumulation of unconsumed fuel contains in itself the latent possibility of starting a conflagration. It is possible that, although we know pure cholesterol promotes cell division, changed cholesterol may fail to do so. A high percentage of unchanged cholesterol, such as is found in carcinoma, would therefore represent an opportunity for undue cell proliferation that is an element of danger. This danger appears to be reduced or eliminated by the action of radium since it is found that the amount of changed (possibly harmless) cholesterol increases in the blood as the condition of the patient is improved by radium therapy.

"The reduction of the blood cholesterol values by the administration of the thyroxin in myxedema, however, cannot be looked upon as the result of photochemical activity. The thyroid hormone is not photoactive. Nevertheless the blood cholesterol values are lowered by the use of thyroxin as well as by radium treatment. We know that the thyroid hormone is capable of increasing the rate of basal metabolism—and that increased metabolism is accompanied by a reduction of the

cholesterol content (Bloor I) of the blood, similar to that produced by radium treatment. This fact, whatever the chemical or physiologic process to which it is due may prove to be, shows that the effect of thyroxin on the chemical composition of the blood is similar to that of radium."

Some Phases of Radium Action with Special Reference to the Hematopoietic System.

Millet and Mueller. J. Cancer Research, 3: 127, 1918.

1. The blood of ten cases of squamous-cell carcinoma of the cervix uteri and vagina has been studied in order to ascertain the immediate and remote effects of radium and x-ray treatments upon the formed elements of the blood.

2. The immediate effects of radium on the blood are not altered qualitatively by previous x-ray or radium treatments, although the quantitative action may be somewhat diminished during a second treatment.

3. The remote effects of radium on the blood are essentially similar to the effects of combined x-ray and radium treatment.

4. Individual slight differences in response to radium applications are often noted to occur again on a second application in the same individual.

5. The immediate effects of radium on the blood are the following:

a. An immediate drop in total white count reaching its maximum from one-half to six hours after the application.

b. A return of the total white count to its former level within twenty-four hours after the application, usually within the first twelve hours.

c. An occasional secondary rise of the total white count to a point well above its original level from twelve hours to three days after the application.

d. A close adherence of the total polymorphonuclear count to the curve of the total white count.

e. An absence of characteristic changes in the total lymphocyte and total large mononuclear counts.

f. A tendency of the total lymphocyte count to follow in some degree the fluctuations of the total white count, especially when these are marked. This effect is not constant.

g. A tendency of the relative lymphocyte count to drop, and of the polymorphonuclears to rise during the course of treatment. This tendency is reversed during the period immediately following the removal of the radium.

6. Remote effects of radium treatment on the blood are as follows:

a. Early.

(1) Fall in lymphocyte count from two to four weeks after treatment, sometimes lasting till the end of the second month.

(2) Fall in polymorphonuclears after treatment, sometimes simultaneous with the fall in lymphocytes but usually coming later and being less striking.

(3) An attempt of the lymphocytes to recuperate, as shown by

a rise in most cases at some later date varying from three to nineteen weeks after treatment, to the approximate level seen before treatment.

b. Late.

(1) Changes in the relative counts as the patient's resistance weakens, with increase in polymorphonuclears and decrease of lymphocytes, but without leucocytosis.

(2) Terminal leucocytosis, due in the main to increase of the absolute polymorphonuclear count, although usually accompanied by an absolute decrease in lymphocytes.

A Metabolism Study of a Case of Leukemia During Radium Treatment.

Knudson and Erdos, Boston M. & S. J., 176: 503, 1917.

The case was a woman, thirty years old, suffering from myelogenous leukemia. The spleen was greatly enlarged, and white count was 495,000 at the beginning of radium treatment.

The treatment consisted, briefly, in applying 50-60 millicuries of radium emanation (50-60 mg. of radium element) to small areas on the abdomen, which was marked off, indicating the outlines of the enlarged spleen. Each area was rayed for four hours during the first series and six hours during the second and third series of treatments. Each series of treatments required three to four days to cover the surface over the area of the enlarged spleen. Between the series of treatments about four to six weeks were allowed to intervene, the time being determined by the examination of the blood.

No attempt was made carefully to regulate the diet, although a record of food taken was kept and found to vary within narrow limits. The diet was practically purin free during and following the series of treatments. It consisted chiefly of bread, cereal, potatoes, milk, butter, eggs, fruit, and occasionally beef, chicken, and a few vegetables.

The urine was collected for 24-hour periods in thymolized bottles and brought to the laboratory for analysis immediately after the 24-hour period was up. At the beginning of the first series of treatments the urine was collected daily from Nov. 6 to 13 inclusive, and after that date it was collected on an average of three times a week except during two periods of a week each when it was discarded because of menstruation.

Total nitrogen was estimated by the modified Kjeldahl method, urea by the urease method, ammonia by Folin's method, uric acid by Benedict's modification of Folin's colorimetric method, creatinin by Follin's method, phosphoric acid by titration with uranim acetate, and the acidity by Folin's method. The urine was at all times during the treatment free from albumin and sugar.

From the experiments it was noted that the volume of urine increased 50% in the first seven days from the beginning of treatment. The total nitrogen, urea nitrogen, and ammonia nitrogen excretions likewise showed remarkable increases in the first seven days. The total nitrogen increased about 115%, urea nitrogen 140% and ammonia nitrogen 150%. The uric acid nitrogen increased less than any of the other nitrogen excretions, only about 28%. The uric acid would be expected

to increase considerably more since the tissue which is disintegrated is rich in nuclein material and should be among the products of disintegration. It may be that the uric acid is broken down further, due to radium having a disintegrating action on uric acid as it does *in vitro*. According to Sarvonat, radium emanation decomposes uric acid, oxalic acid is found among the products of decomposition. Another theory why uric acid may not be increased so much is that of Gudzent and Lowenthal. They found that radium emanation has a pronounced influence on purin metabolism, the action being due to activation of those ferments which are responsible for building up or for cleavage of uric acid according to which ferment action predominates. In this case in which the uric acid would be expected to increase considerably, it may be possible that the cleavage ferment is activated, in which case it would break up the uric acid.

Coincident with the increase of the nitrogen constituents, the total acidity and phosphates show a very decided increase; the former is increased by about 235% and the latter 174%. The total acidity was parallel, to a certain extent, with the excretion of the total phosphates.

After the seventh day of the first series of treatments all of the excretory products show a slight drop. However, these excretory products, in spite of this drop, are at a higher level at the time of the next series of treatments than at the beginning of the first series.

In the second series of treatments it seems that the same effect occurs as in the first series—an increased excretion, the total phosphates reaching in this series on the tenth day an increase of 445% over the excretion for the first day of the experiment. The high level of excretion seems to occur about the tenth day compared to the seventh day in the first series. There is in this series a slight drop in the excretions after the tenth day and then later a rise, so that at the beginning of the third series of treatments the excretions are again at a higher level. It may be that the radium action is still effective at this date or that there is very little or no retention of products at this stage of the disease.

The third series of treatments began January 27. Since excretions were high just before the treatment began, there does not appear a decided increase in any of the constituents except the phosphates on the eighth day after the beginning of the third series.

Conclusions.

1. The excretion of total nitrogen, urea, ammonia and phosphates are enormously increased immediately after the action of radium.
2. The uric acid output is only slightly increased compared to the other nitrogenous constituents.
3. Surface applications of radium over the spleen accelerates the disintegration of nuclein tissue, resulting in the above increases.
4. The phosphates show the most remarkable results, increasing as high as 400% at times over the excretions at the beginning of treatment.

X-Ray and Radium Treatment of Leukemia and Hodgkin's Disease.

1. Levin, Med. & Surg., 1, No. 4:411-416, St. Louis, Chicago, June, 1917.

Definition.

1. Leukemia—bone marrow, spleen, lymph gland are the blood-forming organs which probably take part in forming this disease.

2. Hodgkin's disease—also called pseudo-leukemia; pathologic changes noted in blood, spleen, lymph glands; cervical and axillary lymph glands most frequently involved; lymphosarcomatosis is a type of Hodgkin's disease involving the hyperplastic lymph glands; mediastinal tumor is another type involving the intrathoracic lymph glands; they probably all present one group of diseases of the hematopoietic system; no definite evidence that Hodgkin's disease is caused by an infectious agent; its relation to malignant neoplasms is more probable and borne out by the results of x-ray and radium therapy.

Mechanism of action of x-ray and radium on Hodgkin's disease.

1. Blood, spleen, bone marrow, lymph nodes are most sensitive body organs to action of radium and x-rays; a certain time after cessation of raying the blood-forming organs recover their normal state.

2. Red blood cells are quite resistant to raying action; neutrophile polymorphonuclear cells remain intact longest; lymphocytes and unripe leukocytes or myelocytes are most easily affected especially in the leukemia blood.

Technique of treatment:

1. Coolidge tube used exclusively; focal skin distance eight inches; length of spark $8\frac{1}{2}$ inches.

2. Bauer penetrometer measuring hardness of the rays and milliamperemeter are placed so as to be observed constantly through a lead glass window; hardness of rays is kept at 10 Bauer and 5 milliamperes sent through the tube.

3. Skin field represents a circle one to two inches in diameter; location depends upon region treated; numbers of fields are mapped out, four are treated at every sitting.

4. Regions treated are spleen, shafts of long bones, sternum, chest wall, liver, affected lymph glands.

5. Treatments given three times per week for about six weeks; initial doses 10 x to each field until tolerance is ascertained; dose later increased to 20 x per field; treatment controlled by blood examination; at first blood-smear before and after treatment, later one weekly blood examination; blood picture usually improves in about six weeks when treatment is interrupted; next series of treatments depends on patient's condition.

Results of treatment in:

1. Hodgkin's disease—affected lymph glands rapidly diminish to a certain extent under x-ray, more readily under radium treatment; marked improvement in general health of patient; treatment should continue for months; if interrupted for a time the first evidence of new glandular enlargement indicates repetition of treatment; unsatisfactory and merely palliative results are probably because radiation was begun

only late in course of disease and not pursued with sufficient energy; in a few early cases radiation has succeeded in arresting the disease for a number of years.

2. Splenic pseudo-leukemia—radium acts more promptly on enlarged lymph glands; combined x-ray and radium treatment therefore advisable; in majority of cases condition subsides under this treatment and life is prolonged.

3. Mediastinal tumors—one form of Hodgkin's disease; fluoroscopic chest examination necessary in early cases; immediate energetic raying of chest whenever enlargement of mediastinal glands is observed; clinical symptoms usually expressed in advanced stage of disease; results of treatment therefore temporary; yet many cases are reported where x-ray plates before and after treatment show marked decrease in size of tumor and improvement in general clinical symptoms.

4. Lymphosarcoma—a malignant degeneration of hyperplastic lymph glands; a late stage of Hodgkin's disease; a priori results of x-ray and radium treatment can therefore be only palliative; yet cases are on record where far advanced disease was kept in check for as much as a year and a half, or some of the affected glands completely disappeared under radium treatment.

Conclusions:

1. Leukemia and Hodgkin's disease are the most hopeless conditions in medicine.

2. X-ray and radium treatment should be given as soon as diagnosis is made; results of these treatments are most encouraging; treatment must be conducted with great energy.

Hemolysis by Means of Radium Rays.

W. Hausmann, Wien. klin Woch., 29: 1289, Oct. 12, 1916.

Red corpuscles suspended on an agar plate were completely destroyed at the end of a thirty-six hour exposure to radium rays (the destruction was seen to start in less than twenty-four hours). Further experimentation proved that this effect should be ascribed to the beta rays.

Radium. Its Physio-Chemical Properties Considered with Relation to High Blood Pressure.

C. E. Field, Med. Rec., 89: 135, 1916.

According to von Noorden, radioactive elements exert forces which, in accord with the definite laws of physics, markedly influence biologic processes. Furthermore, the chemicophysical properties of radium may be traced in the human body even in the minutest doses. Metabolism, while classed as a body chemistry, is in itself dependent to no small extent on physics. In the laboratory radium readily activates and intensifies fermentative and digestive processes; within the body, it stimulates even more actively the numerous ferments. The efficiency of radium in catalysis and autolysis will be better understood if for a moment we review a few of the commonly well-known facts as regards this element.

Radioactive substances present three distinct products of disintegration which we term rays. Alpha rays are positively charged helium atoms and constitute 90 per cent. of the energy of radium. Beta rays, also electrons, in turn are negatively charged particles. Gamma rays are not material in nature, being classified as exceedingly short-length waves of ultra violet light. In the process of decay or transmutation, something happens within the tiny atom of radium, and much as the meteor flies from the planet, the alpha ray is spontaneously thrown off into space with a speed of over 12,000 miles per second. From this another and still another particle is born until the entire series in evolution is complete. In common with the liberation of the alpha particle, we have the formation of a gaseous substance known as emanation, which contains in itself all of the power and energy of radium. The radiations of emanation acting as carriers of enormous energy within the body develop heat and electricity and foster chemical transformation. By its use we permeate the body with a stream of electrons through the channel of the blood stream. It carries a *normalizing* activity to the tissues, fluids, protoplasma, cells, and nuclei. Therapy with radioactive substances may be designated as the administration of *fluid electricity*. This is probably the most clear description we could give of its physical force and purpose.

To have the radium situation clearly before our minds, we must acknowledge that much of the early experimental research with radium had many of the hindrances common to the study of so rare and new an element. The theories relating to the causative features of high blood pressure are many; but for our immediate need we care not to debate now whether it is due to a hyperplasia of the suprarenal capsule or, according to the old theories of Cohnheim and Traube, to mechanical interference in the flow of the blood stream, for we may content ourselves in the belief as clinicians that faulty ferments of toxic origin are the basic factors.

From the earliest experiments to the present, lowering of high blood pressure during radium treatments has been the common report. Physiochemical processes are exact and the physiological and biological manifestations that follow must to a similar degree, be definite. Therefore it is that, in almost 95 per cent. of the high blood pressure cases treated, certain improvements are promptly noted, precordial distress, headache, vertigo, disappear at times even with small dosage. The general energy of the heart is markedly improved, and peripheral resistance is reduced. A factor that by some has been discounted is the viscosity of the blood; yet a change in type exerts an enormous influence on the arterial system—under emanation it is rendered less viscid. The elasticity of the muscular wall of the artery relieves the heart of much unnecessary load. When the tonicity is low, increased tension results. Radium emanation improves the general muscle tone of the entire system. All these processes naturally are the outcome of the influence of radium on the various ferments that may be disordered.

Recognized early, metabolic processes may be promptly improved with the hope of a permanent cure. We have a right to assume that the process of hypertension can be checked so as to prevent the development of a nephritis. Indeed, there is a reason to believe that Bright's disease as a symptom may be wiped out. When nephritis and cardiac

lesions are advanced, the pathological processes can surely be held in check and life in a measure conserved; while at the last stake with a broken compensation we may sustain the patient by lowering tension, building up resistance, increasing somewhat the elasticity of the blood vessels, thereby lessening the danger of their rupture and materially adding to the comfort of the patient.

So far as dosage is concerned in high blood pressure we are largely governed by the chronicity of the case and the involvement. Personally, the author feels his best results have been shown in what we would term low dosage. Delano of Boston has checked up some exceedingly important findings derived with low dosage. He has found his average dose to be 4 micrograms daily. It is the author's usual plan to give an injection of one 25-microgram (radium chloride) ampule (2 c.c. normal saline solution), and following with a solution of distilled water, 2 oz., containing 2 micrograms of radium chloride given by mouth as one dose three times a week. After four weeks this drinking solution is cut to two doses per week. While the results are prompt, he never accepts a case for less than twelve to sixteen weeks' treatment and observation. Careful histories of the laboratory findings are always to be made. The patient may or may not be placed on diet and other rules of hygiene as may seem indicated. In private cases he would, of course, observe the above, in others he has preferred to watch the results without special or rigid diet. Under such a treatment we have a right to expect by far the large majority of cases of systolic pressures (running from 160 mm. to 200 mm.) to be influenced to drop from 15 mm. to 40 mm. As a rule, active symptoms such as precordial distress, vertigo and headache disappear in many cases within a few days.

Where radium solutions per os alone are given, the dosage starts at 6 micrograms per day in three doses; this to continue for four weeks as a rule, then to follow at 6 micrograms per week for the balance of the course. This plan of treatment does not give as uniformly good results as a course inaugurated with an intravenous injection. The plan of insisting on the long time treatment was arrived at, owing to the fact that after the initial drop in pressure, or within five days, the patients generally felt so much improved that there was a tendency to discontinue treatment. It was necessary to make it clear that the early relief had nothing to do with the permanency of the effect most to be desired. In dealing with a disordered metabolism of long standing it would be unwise even to assume that radium would accomplish the impossible. Patience and real radium with or without a portion of psychology are necessary factors to the successful administration of those cases. In your mind will naturally arise the question, what of the permanency of such treatment. To this the author replies that fully three-fourths of the cases have held without further treatment for from six to twelve months. There are many of the early cases treated nearly two years ago that have suffered no material rise. Others where pressure has gone up sufficiently to produce symptoms have been quickly touched up with a two or three weeks' treatment. Some of these returned with their trouble on account of growing bold with their diet. An interesting feature in a large number of cases has been an activation of sexual powers. Insomnia and nervous symptoms are improved and the patients invariably take on a feeling of well being.

Compensatory functions can be sustained and greatly improved at times with extremely low dosage of radium. In such cases we may observe both systolic and diastolic pressures slowly coming down in a fairly even proportion. Although the author can find no record of any unfavorable action following the administration of the soluble salts of radium, he would naturally urge caution in attempting sudden reduction in compensatory high pressures. Here must come a full understanding as to the type of compensation. For the purpose of this paper he has intentionally refrained from dealing with compensatory cases and his selection has been a measure confined to those types showing relatively a high systolic and a low diastolic pressure. In a series of 135 cases classified, the average systolic pressure was 190 and the average reduction showed at 40 mm.

Radium, X-Rays and the Living Cell.

Colwell & Russ, London, 1915, Chap. 7, p. 176, G. Bell & Sons.

V. Noorden and Falta showed that an increase in the number of white cells occurred in the blood of certain patients submitted for some hours to an atmosphere containing emanation and that this increase was sometimes followed by a decrease.

As a result of observation on blood counts at various intervals before and after the injection of radium in dogs and rabbits by Brill and Zehner, they state that after the first rapid rise in the number of red cells there is a further important increase and this may reach as high as 13,000,000 per c. mm.

The increase is a function of the amount of radium per Kilogram weight of the animal. Pathological forms of blood cells were not met with.

In a summary of their work they state that on the leukocyte system there was in all cases a strong stimulation, but with strong doses there is also a harmful effect upon the red cell system; they only observed a stimulating effect, which in many cases lasted a long time.

Chambers and Russ showed that the red cells of the human blood are hemolysed much more easily by the alpha rays than by the beta and gamma rays; in fact, no hemolysis was observed with quantities very much larger than the ionising effects of these rays would have indicated as being sufficiently large to produce hemolysis.

The leukocytes are also affected by exposure to the emanation. Prolonged exposure leads to the complete disintegration of the leukocytes.

Benjamin, Reuss, Slenka and Schwartz showed the susceptibility to the x-rays of the lymphocytes: there is a decrease, and the increase in the polymorphonuclear leukocytes that often results from an exposure.

Tartarsky considers three ways in which the lymphocytes in the blood may be destroyed—(1) the lymph glands and follicles may be specially sensitive to the action of the rays, their function being so interfered with that the production of new cells is hindered or completely stopped; (2) they may be destroyed in the circulating blood; or (3) the normal evolution of the lymphocytes to the polynuclear leukocyte may be accelerated under the action of the rays with the result that

there is a reduced number of lymphocytes found in the circulating blood. Tartarsky considers the first to be the most probable way in which the x-rays act.

Aubertin and Beaujard call particular attention to the oscillatory nature of the graph before a normal condition of the blood is reached. From the detailed blood counts it is possible to trace the variations of each class of white cell and in this way determine the relative part they play in the process by which the blood returns to normal.

During the leukopenia, the polynuclear forms generally decrease in number but not so greatly as other varieties. A notable increase in the eosinophile and mast cells is a further evidence of a state of hyper-activity in the bone marrow together with a reduced activity of the spleen.

As a general conclusion they state that: "A medium dose of x-rays causes a condition of hyper-activity of the bone marrow which, though apparently paradoxical, is the more accentuated the more marked the decrease in the leukocyte content of the blood; this condition disappears only when the blood content is normal."

Changes occur in the human blood as a result of chronic exposure to x-rays. Aubertin states that the blood of seven radiologists in good health was not quite normal, the most marked feature being a diminution of red cells.

Senn discovered that x-rays have a beneficial effect upon the blood in leukemia. Bruce and Ledingham in cases of spleno-medullary leukemia found that the bone marrow was in a markedly hypoplastic condition; the neutrophile elements were found to be almost entirely replaced by undifferentiated basophile myelocytes in a proliferating condition. Ledingham cautions against the continuation of x-ray treatment once the total leukocytes are normal.

It is not definitely known how far the Beta rays penetrate the tissues of the body, while the penetrating power of the gamma rays is much greater than that of the beta rays.

They correspond on the average to a very hard type of x-rays, more penetrating than any x-rays yet produced by mechanical means.

The clinical importance of secondary radiations, whether induced by beta, gamma or x-rays, is difficult to estimate.

Ionisation due to beta rays is less intense and less localized, while the gamma rays have a small ionising action, which may, however, be distributed over a very large space.

Generally speaking, the penetrating power of x-rays lies between that of beta and gamma rays. It is, however, possible to produce x-rays which are more easily absorbed than swift beta rays are; and on the other hand "very hard" x-rays are more penetrating than the softer types of gamma rays.

The Value of Radium and X-Ray Therapy in Hodgkin's Disease.

Harry H. Bowling, J. Radiol., 2:20, Dec., 1921.

The etiology, pathology, symptoms, differential diagnosis, prognosis, and treatment of Hodgkin's disease are discussed. In all early cases of glandular enlargement, an isolated gland should be removed

for examination by a pathologist. For radium treatment the author employs 50 or 100 mg. doses of salt of emanation, contained in either silver or brass capsules of 0.5 mm. thickness, and filtered in addition through 2 mm. of lead, the radium being held at a distance of 2.5 cm. from the skin by means of a gauze pad or a wood block. Twenty hours of treatment are given with the silver tube, and ten with the brass. Two to four areas are usually radiated at one time with intervals of two to three days from 5,000 to 6,000 mg. hours being applied to each right and left cervical and supraclavicular area and inguinal areas, and from 1,000 to 3,000 to the auxiliary areas.

In giving x-ray treatment, a 23.7 parallel spark-gap is used with 5 milliamperes of current, the distance being 30.5 cm., the time twelve minutes, and the filtration 6 mm. of aluminum and a piece of sole leather. The chest is divided for treatment into four areas and the back into eight. Exposures are repeated every three weeks until 6 or 8 treatments have been given; then an interval of three months is allowed to elapse. The x-ray treatments are usually given at the beginning or at the end of the radium exposures.

Bowling believes that the life expectancy of the patient should be increased by intensive radium treatment of the superficial glandular enlargements and deep x-ray therapy of the thoracic and abdominal cavities, whether the roentgenograms are positive or not. Huge glandular enlargement and mediastinal involvement are markedly diminished. The generalized pruritus may diminish and in some cases may entirely disappear.

Radiation in the Treatment of Leukemia.

A. Soiland, J. Radiol., 2: 25, Dec. 1921.

The effects of radiation from the x-rays and radium are apparently alike. If radium is used, a sufficient amount must be employed to insure deep effects. The author frequently employs radium over the spleen and x-radiation over the osseous structures and glandular fields.

Technique for radium over the spleen that the author ordinarily employs is the following: The area is divided off into squares, eight centimeters in diameter. One hundred milligrams radium element, with one-half millimeter of silver, one millimeter brass, and two millimeters hard rubber filter, are placed in a wooden block, the whole wrapped in gauze, making a skin distance of three centimeters when applied. A total of fifteen hundred milligram hours is applied to each of the eight centimeter squares. At the end of this series, a blood count is made, and upon the findings thus obtained, additional treatment is regulated to suit the individual patient. It has not been found necessary to use radium over the bones.

SECTION VIII
RADIUM IN THYROID AND GOITER

SECTION VIII.

RADIUM IN THYROID AND GOITER

Pathologic Classification of Thyroid Gland Diseases with Radium Treatment in Toxic Goiter.

R. E. Loucks, Am. J. Roentgenol., 8: 755, Dec., 1921.

Loucks believes that radium is the treatment of choice. He recommends the use of at least 100 mg. in four tubes, screened in 1 mm. of brass and 1 mm. of gum rubber, and placed on a gauze pad 2 cm. thick. Two or three areas are treated, depending on the size of the gland, the size of the pad, and the amount of radium. The exposures vary from eight to ten hours over each area. From careful observations on a number of cases, Loucks finds that the systolic blood pressure is lowered in those cases in which there is a high blood pressure, although the degeneration of the heart and kidneys has not become permanent, and that the blood pressure is raised in those cases in which compensation has been reestablished.

In patients with a metabolic rate around 80, it was lowered for the first two weeks, raised for the third and fourth weeks, and then gradually decreased for the next few months. In those with a metabolic rate above 100 with broken compensation it gradually decreased after the third week. The metabolic rate was found to be normal in many very active cases three months after treatment.

Metabolism being the standard of toxic activity, the rate measurement will verify clinical findings, prove results of treatment, and show a physiological indication for future measures.

Radium Emanations in the Treatment of Goiter.

W. I. Terry, J. A. M. A. 76: 1821, 1921.

In the treatment of bad risk cases of exophthalmic goiter, it occurred to the author that radium emanations could be introduced into the substance of the thyroid under local anesthesia, and with a minimum of traumatism. He inserted eight tubes of radium emanations, representing ten millicuries, in the case of a patient with an extreme degree of hyperthyroidism with exophthalmos. Since then he has employed a similar procedure with ten other cases. With the advice of Dr. L. R. Taussig, the dosage of emanation has been reduced to six or seven millicuries and is contained in about six minute capillary tubes.

The technic is simple. Under local anesthesia, a spinal puncture needle of small calibre, is introduced into the thyroid. The tube is pushed out of the needle by an obturator slightly longer than the hollow needle. This procedure is repeated until all the tubes containing radium are deposited in various parts of the thyroid gland. The emanations thus act from within the goiter and tend to inactivate it and prepare the patient for operative treatment should it be deemed advisable.

It is not expected that this form of radium treatment will supplant ligations, but it offers lessened risk, according to the author's opinion. Of the eleven patients four were considered sufficiently improved, after a lapse of from four to ten weeks, for partial lobectomies. One patient

died of acute hyperthyroidism following a partial bilateral lobectomy. The other seven patients are still under observation and have shown improvement.

Radium Treatment of Enlarged Thymus Glands in Infants.

A. C. Heublein, Am. J. Roentgenol., 7: 191, 1920.

The author was called into consultation to see an infant practically moribund from the effects of an enlarged thymus gland. Although roentgen therapy was recommended as up to this time it had proved to be the only effective method of treatment, yet partly from an experimental standpoint, and also in view of the fact that with radium the author had observed a rapid diminution in the size of other pathological overgrowths, he departed from the accepted method of treatment and used radium.

The result was so eminently satisfactory that he has treated all other cases in a similar manner. The technic which was followed was cross-firing with 100 milligrams of radium element, filtered through 0.3 mm. silver, at a half-inch skin tube distance through four portals of entry, the tube being placed over the anterior aspect of the chest directly over the thymus gland. The tube is left two hours in each position, which makes a total dosage of 800 milligram hours. As time is such an important factor in these serious cases, the author has now substituted 200 milligrams with half the time of exposure.

In a series of 41 cases the dosage administered seemed to be sufficient to cure large as well as small thymic overgrowths in one application, and as now it is conclusively proven that the thymus has no function after birth, there is no need to fear over-treatment. Possibly these results could have been obtained by a single intensive X-ray treatment, but in a review of the literature, no such results seem to have been reported.

The author, in concluding, emphasizes the following points: Thymic enlargement is a common disease in infants. Radium as well as the roentgen ray is specific in its effects, but radium has the following advantages: It is portable; it gives the desired result in one treatment; it is simple, thus eliminating the dangerous element of fright, as infants resist the fixation necessary in roentgen ray treatment, and this very fixation may be the exciting cause of thymic crisis and death; radium is a safe procedure, as the skin tube distance never varies in the most refractory child.

In the four cases reported, all treated by radium, the babies became normal within a week at the outside, and have remained so ever since.

Radium in Exophthalmic Goiter.

W. H. B. Aikins, N. Y. M. J., 104: 49, 1916.

The author has been very favorably impressed by the use of radium in exophthalmic goiter, especially since it has proved to be efficacious in cases where medicaments, organotherapy, x-rays and hydrotherapy have given only mediocre results, or none at all. Abbe, of New York, first used radium successfully in exophthalmic goiter,

and his favorable experience of its results has been repeatedly confirmed by other writers. The experiments of Victor Horsley and Finzi show that the most constant changes after the application of radium affect the blood and lymph vessels. The author's own clinical experience shows that, when applied over the thyroid, the more penetrating radium rays diminish the vascularity and reduce the secretion of the gland.

Dawson Turner, who has had very favorable results, thinks that radium has two definite advantages when compared with the x-rays, i. e., (1) the possibility of giving definite doses; (2) the fact that it can be applied without noise or excitement, while the patient remains in bed.

The author then gives detailed reports of seven cases of exophthalmic goiter successfully treated with radium.

Case 1.—Three thyroidectin tablets, each containing five grains, were give daily, and in addition a radiation of 100 mg. hours was given with a large radium plaque. A week later the circumference of the neck had diminished from fifteen inches to fourteen, the pressure symptoms were better, and the patient felt better. Five weeks after beginning the treatment, the neck measured thirteen inches, the tumor had almost disappeared, and the patient has been well ever since.

Case 2.—The treatment adopted was rest in bed, ice bag over the heart, and administration thrice daily of a quinine hydrobromide capsule. The thyroid gland was subjected to a heavy exposure of radium rays. Three months later the neck had gone from fourteen inches down to twelve and one half; tachycardia and nervous symptoms disappeared. Further radium treatment has since been given; patient has now continued well for over two years, and has resumed her normal life.

Case 3.—Neck measurement sixteen and three quarters inches. Radium applied to the thyroid brought the circumference to twelve and one half inches.

Enormous Goiter with Grave's Disease; Permanent Health Six Years after Cure Following Radium Treatment.

R. W. Abbe, Ann. Surg., 54: 235, 1911.

Dr. Abbe presented a woman who had suffered from exhausting symptoms of Grave's disease for a year and a half; to wit, palpitation, suffocation when lying down, tachycardia (pulse 120), trembling, progressive feebleness, anorexia and perspiration, enormous increase in the thyroid, with dyspnea, inability to ascend stairs, and with moderate exophthalmus.

As the goiter was hopelessly inoperable, and as some claims had been put forth for the Roentgen ray treatment of goiter, as well as for operative work, on the cervical sympathetic ganglia, Dr. Abbe conceived the idea of radiating the neck and goiter by inserting a strong radium tube into the goiter for twenty-four hours. No other treatment was adopted excepting occasional enemata and the use of Carlsbad salts.

The goiter began to subside in two weeks, and in eight weeks was so far reduced as to be nearly normal. The patient was soon restored to health, and during the following six months was able to walk many miles daily, to play tennis and to resume her usual occupations. She has remained in perfect condition for six years, with no return of the goiter.

Dr. Abbe, in reply to a question as to whether he had employed the radium treatment in other cases of exophthalmic goiter, said he had treated many cases with this remedy; most of them had shown distinct improvement, and some were cured, as was this one. He had selected this case for presentation on account of the enormous size of the goiter.

SECTION IX

RADIUM IN UROLOGY AND DISEASES OF THE
GENITO-URINARY TRACT

United States Radium Corporation
New York

SECTION IX

RADIUM IN UROLOGY AND DISEASES OF THE GENITO-URINARY TRACT

Experience with Radium in Cancer of the Prostate.

H. G. Bugbee, J. Urol., 6: 459, Dec., 1921.

The author used the strong cystoscope holder of Young to grasp a rectal and urethral applicator, thereby maintaining the radium in accurate and close apposition with the area treated; he also applied the radium needles through the perineum in the center of the lateral lobes, according to Barringer's method, using the screened element instead of the bare emanations. In addition he employed superapubic drainage in every case of retention of more than a few ounces; in the future he intends to establish a suprapubic opening in all cases of external involvement because the part of the prostate about the urethra and vesical orifice is the part that is most effective in causing obstruction and retention. The gland protruding into the bladder and underneath the bladder mucosa is most difficult to reach by perineal needles, while intravesical surface applications have a limited action, are poorly borne and cause irritation. The needles plunged into the midst of a growth tend to honeycomb it and when this is followed by surface applications, the mass rapidly recedes. Before beginning treatment, the patient should be carefully examined for the presence of bone or visceral metastases, the condition of the blood and the urinary and intestinal functions. Seventeen case histories are given in detail. The general condition of the patient requires careful consideration and a certain amount of body resistance must be present; elimination must be active and the blood index good if cancerous tissue is to be destroyed and eliminated without causing profound toxemia. Elimination is favored by giving digestible, nourishing food, by maintaining intestinal function, by diet, by mild cathartics and by colonic irrigations. Large doses of bicarbonate of soda are given and iron is beneficial. In fifteen months, changes were noted in cancerous prostates, observable with no other form of treatment.

Of the 17 cases, 5 were treated by radium needles through the perineum and direct applications to the rectal surfaces of the prostatic lobes, using a specially constructed applicator, the radium screened with gold and guttapercha and held in position by a strong clamp; the prostatic surface is carefully mapped out and the applications are accurately made and distributed. Four cases also had intra-urethral applications. Of 4 patients given suprapubic drainage only, all showed symptoms of systemic cancer, the drainage only relieving the intense bladder symptoms; in these cases, an attempt at destruction of the cancer by radium would have only added a toxemia. Two cases died of systemic disease and the other two are alive but failing from general carcinomatosis. The four cases opened suprapubically and given needle applications from above and also perineally showed retention and extensive involvement, 1 of which empties his bladder with a healed drainage wound, a second is draining although no growth is palpable, and the other two have suprapubic tubes with the growth diminishing rapidly in size. By suturing a Pezzer catheter into the bladder wall when the needles are

introduced suprapubically, the needles can be withdrawn and the wound closes tightly at once, allowing the patient to go about his business immediately. One patient, in whom a resection of the bladder wall and prostate was done with external application of radium, was free of recurrence one year after operation. The last case treated by perineal needles only was improved. In slowly growing cancers, better results obtain from suprapubic destruction of the gland followed by surface applications. As cancer cells have been demonstrated pathologically after radium treatment, it becomes questionable whether or not it is possible to destroy the entire growth. The term "cure" should not be used in these cases.

The author has seen the best results from exposure of the prostate suprapubically, destruction of the cancer by radium needles introduced through the prostate from above, close to and parallel with the urethra; from needles introduced into the prostate through the perineum and late surface radium applications accurately made, while drainage is maintained. The return of bladder function may be tested by clamping the suprapubic tube. When voiding is free and no growth is palpable through the suprapubic sinus, the fistula is allowed to close and treatment is continued through the perineum by needles and the rectum by surface applications, as long as any growth is palpable.

The Treatment of Cancer of the Rectum by Radium.

Douglas Quick, Am. J. Roentgenol., 8:746, Dec., 1921.

Quick thinks the term "cure" should be abandoned and that the results should be described as apparent freedom from the disease or "clinical cure" for a fixed period.

Every case of rectal cancer should be classified in 1 of 3 groups, depending on the extent of primary growth, metastases or probability of metastases, age and general physical condition. In Group I should be placed all cases in which a reasonable hope for complete regression can be entertained; in Group II, advanced cases in which a reasonable hope for palliative relief can be entertained; and in Group III, hopelessly advanced cases in which the physical agents hold out no chance for relief. Such a classification is necessary for the formulation of a plan of treatment for each individual case. With better medical education, lessening of fear and distrust on the part of the patient, and improvement in technic with the physical agent, Group III should be steadily reduced.

In Group II, the first consideration must be the comfort of the patient. If surface applications of radium internally will relieve discharge, bleeding, pain, and obstruction and prolong life then it should be so employed, but not to the point of serious discomfort. In these cases, buried emanation should be used sparingly if at all, as the reaction from large doses is too severe to warrant its use for purely palliative relief. In some cases a colostomy may be an urgent necessity.

In Group I, radium should be used in as large doses as possible and through all available channels, to effect a complete regression of the growth. In the majority of the cases an exploratory laparotomy is advisable and can usually be done under local anesthesia with very

little risk to the patient; it frequently offers a much more accurate means of introducing radium emanation into the upper portion of the growth. If it is found that a temporary colostomy will facilitate treatment it can be done at the same time. In many of the smaller growths a laparotomy is not essential for localization of the disease, as they can be treated very accurately through the proctoscope. Treatment of these smaller lesions is not attended by an appreciable amount of discomfort, but there is justification in subjecting a patient to this where there is a reasonable hope for complete regression of the disease. Emanation in sufficient amount should be distributed accurately and uniformly throughout the growth, preferably under gas and oxygen anesthesia. Filtered radium should be applied internally in every way that the anatomical relations of the individual case permit. In certain cases, especially bulky growths involving the small sphincter, surgery may be employed to advantage after intense radiation.

The statistics of surgery alone even in the strictly operable cases leave much to be desired, and unfortunately sufficient time has not elapsed to permit of the determination of radium treatment with the improved methods of application. Quick thinks, however, that past experience warrants the treatment with radium of operable as well as of some of the more advanced cases.

Radium Therapy of Teratoid Tumors of the Testicle.

B. S. Barringer and Archie L. Dean, Jr., J. A. M. A., 77: 1237, Oct. 15, 1921.

Treatment by radiation and then operation for teratoid tumors of the testicle, as advised by the late Dr. Janeway, has given some brilliant results. These tumors may be divided into adult embryomas or teratomas, which are comparatively rare, grow slowly and respond less readily to radium; embryoid, teratoid or mixed tumors, which are more frequent than the foregoing; and, embryonal malignant tumors, which are most often seen, grow quickly and respond well to radium therapy. The tumors arise, with rare exception, from sex cells situated in the rete testis and the teratoma may develop either toward the testicle and epididymis, involving both in a large tumor mass, or much more rarely toward the epididymis, forming a typical tumor of the epididymis. Diagnosis of these tumors is often difficult although when the tumor is typical, the whole testicle is an irregular, hard mass in which no distinction between the testicle and epididymis can be made and the main diagnosis is between teratoma and gumma. However, a positive Wassermann test usually indicates gumma, although one patient with a positive Wassermann test had teratoma testis. In two cases the teratoma grew atypically and involved the epididymis alone, giving a picture not unlike tuberculosis of the epididymis. Preoperative diagnosis is very important because the author knows of no patient in whom the tumor was incised who did not succumb to local recurrence. When the teratoma occurs in an undescended testicle the diagnosis is most difficult. Present operative methods, like orchidectomy and the radical operation show poor results.

The operative technic approved by the author is carefully explained.

Following a careful physical examination, with roentgenograms of the chest, and when distant metastases are not found, the testicular tumor, spermatic cord and abdomen along the tract of the spermatic vessels are treated with the radium pack and the patient goes home, returning for weekly examination. With rapid reduction in the tumor, delay operation for weeks or months to get the maximum effect of radiation; but in tumors which do not decrease in size, operate in three to six weeks. In operating, the testicle is not handled before its vessels and lymphatics are cut lest tumor cells be squeezed into the general circulation. Any glandular metastases are dissected out and tubes of screened radium introduced for a time. Finally the vessels are cut high up and the testicle is dissected out and removed and the wound sewed up. This operation has been performed 8 times with no postoperative deaths and does not seem to be serious. From three to six weeks after the wound is healed, radium packs are again applied over the length of the scar. Both early and late cases show recurrences after operation and even in one of the primary operable cases of the adult type, irradiated before and after operation, the patient died of recurrences some months after operation. Although teratoma testis is extremely malignant, the author believes that radium is a very valuable adjunct to operation in dealing with the disease.

The Use of Buried Emanation in the Treatment of Malignant Tumors.

H. H. Janeway; Am. J. Roentg., 7: 325, 1920.

The conclusions upon the advantages of this method have been confirmed.

Indications for the use of buried emanation:

Prostate and bladder—The emanation tubes are buried in the prostate through the perineum, or when accuracy requires, may be introduced safely through the anterior wall of the rectum.

The chief advantages of embedded emanation for the growths of the mucous membranes above mentioned are the accuracy of the primary application, the economy in the use of radium, and the ease with which residual incompletely treated remnant of the tumor, left after the initial treatment, may be destroyed by embedding emanations in these remnants as soon as they are identified. Often one such supplementary treatment of the tumor process is sufficient to dispose of a growth from which otherwise a fatal recurrence would take place.

The most important detail in the successful treatment of these growths is the correct interpretation of the changes in the post-therapeutic period.

Dosage: It is difficult to formulate rules for dosage, and such rules are always subject to modifications imposed by the special conditions present in any case.

The volume of the tumor is the most important factor in determining the dose, but the shape of the growth is of almost equal importance, and influences the dosage hand in hand with the volume. An elongated superficial growth will, for instance, require almost the same dose as a circular superficial growth with a diameter equalling little less than

the long axis of the elongated tumor. A flattened tumor with little deep infiltration requires approximately the same dose as a spherical tumor with a diameter equalling the long diameter of the flattened growth. Between these variously shaped tumors there is a great difference in cubical volume, but the difference in the number of the millicuries required by them is not proportional to this difference but rather to the difference in the number of square centimeters in the plane of the tumor's largest diameter. For these reasons the diameters of tumors are the most practical guides to the doses required by them. (The author gives a table with the approximate dosage used at the Memorial Hospital for epidermoid carcinoma, etc.)

Radium Therapy of Cancer of Bladder and Prostate.

G. Kolischer, Am. J. of Surg., vol. 34, p. 323, 1920.

Gold seems to be the best material for radium filters in bladder work, first, because the filtering capsule does not have to be very thick, on account of the high atomic weight of the metal, thus permitting easy introduction through the natural channels; and second because in eight years' experience the author has never noticed any damaging of pelvic or abdominal organs.

The time of primary introduction of radium into the bladder depends on the condition of the viscus. If there is no appreciable cystitis the radium may be inserted without any preparatory steps.

Tumor cases that are accompanied by infiltrating cystitis of such a degree that the bladder is unable to retain even very small quantities of urine are not proper objects for primary radium application. Such bladders are opened by the suprapubic route. Thus the annoying strangury is relieved and at the same time the tumor is made easily accessible for the treatment preparatory to the application of radium. The preparatory treatment is electro-coagulation of the accessible parts of the growth. The surgical diathermy immediately does away with hemorrhage and pain and furnishes another advantage: The stimulation of a malignant tumor occasionally observed under raying never occurs in instances of previous electro-coagulation.

The radium treatment may follow immediately the coagulation of the growth; in fact the radium rays seem to enhance and accelerate the detachment of the eschar produced by the diathermy.

The application of radium to prostatic cancers is conducted on the same principles. Prostatic cancers causing pronounced pains due to the capsular tension, that are not promptly relieved by radium, call for suprapubic opening of the bladder and electro-coagulation of the prostatic tumor.

For the placing of radium or similar substances into the unopened bladder, the author uses a silver sound, the tip of which consists of a detachable hollow gold tip of 3 mm. thickness into which the glass container carrying the radio-active substance is placed. This sound has a calibre of 21 Charrière. Frequent urination is encouraged to keep the bladder contracted. This, together with the fact that the irradiation of radium through a gold container will always extend to at least 4 cm. distance, will always insure that at least one part of the tumor is under

the influence of the therapeutic rays. If the bladder was opened previously to the radium application, the container and filtering capsule are dropped into the bladder through the suprapubic opening.

The author leaves the radium container in the bladder for 24 hours and repeats the treatment once every week, utilizing the intervals for antiseptic treatments of the viscus.

If it is deemed advisable to apply the radium per rectum to a prostatic tumor, a heavy lead cap is slipped over the filtering capsule to protect the rectal mucosa, which is susceptible to the destructive influence of radium rays. In this cap a little fenestra is cut; the container is then placed in the rectum in such a way that this opening lies against the prostate, while the balance of the rectal ampulla is entirely screened off. In order to maintain the capsule in this position it is connected with a stiff rod that carries an adjustable curved cross bar which is made to fit into the anal rim, in which position it is fastened by tape or adhesive.

The author injects proteus enzyme into the prostatic tissue which seems to enhance the radium action.

If a few radium treatments do not produce decided improvement, continuance is hopeless and the author resorts to electro-coagulation. Fifty mg. of radium or mesothorium is sufficient for the application to vesical or prostatic tumors.

Carcinoma of the Bladder.

B. Lewis, Urol. & Cutaneous Rev., vol. 24, p. 6, 1920.

It is generally agreed now that benign tumors are curable by means of fulguration; that malignant papillomata are amenable to treatment with fulguration and radium; but a division of sentiment comes with regard to infiltrating carcinoma. Geraghty holds that this is made worse by fulguration, but may or may not prove amenable to radium therapy. Everyone recognizes the greater resistance and rebelliousness of the latter form of tumor; but that it is without the pale of curability or is inappropriate for fulguration is yet to be proved. Certain of our cases seemed favorably influenced both by radium and fulguration; and no little credit has been given to the intensive employment of x-ray with the Coolidge tube as recommended by Pfahler.

We are under the impression that the use of radium and x-ray prepares the growths for greater amenability to fulguration, and are in the habit, in the infiltrating cases, of using them first and fulguration (d'Arsonval current) later, if there is pronounced tumefaction.

The author gives five cases of carcinoma of the bladder, which were treated with radium or x-ray or both, followed by fulgurations, with the following results:

Case 1. April 14 to 18, 1917, patient received 18 hours application of radium.

During the next three months, 14 fulgurations were done, when the tumor, and all bladder symptoms entirely disappeared. The patient is well now three years since treatment was begun.

Case 2. After a series of intravesical radium treatments (begun July, 1917), 13 series of x-ray exposures and numerous fulgurations, patient has improved to a state where she weighs more than ever before, does housework, etc. Tumor mass has decreased until in Sept., 1919,

there was no tumor visible, but only an indurated, ulcerated mass the size of a silver quarter. There is still slight incontinence and the patient is not well, but the improvement has been great.

Case 3. July, 1918: 34 hours of radium, x-ray treatments and fulguration every 3 or 4 weeks. Tumor has been reduced to the size of a small pea. Patient feels improved.

Case 4. March, 1917: 50 mg. radium for 2 hours. Repeated 6 days later. Fulguration at intervals of a week to a month. Ulcer gradually disappeared. Dec., 1918; mucosa smooth and healthy. Good report recently received from the patient.

Case 5. October 21, 23 and Nov. 2, 1918: radium; following this four series of X-rays and nine fulgurations were given. April 1919: tumor had entirely disappeared. October, 1919: all bladder symptoms gone and patient well.

Experience with Radium in the Treatment of Diseases of the Urologic and Cutaneous Systems.

J. M. Lee, Urol. & Cutan. Rev., 24: 575, 1920.

"Although some German observers and others dissent, most surgeons accredit radium with a selective action for diseased tissues. This is especially marked in most forms of malignancies, in which it changes the cells back to more nearly the embryonic type from which they developed. This selective action is not so pronounced in growth of epithelial tissue as it is in those of connective structures; neoplasms, here particularly, are about six times more readily acted upon by the radium than the normal tissues which surround them. In many cases the growths soften, shrink and disappear without destruction of the normal tissues, in such a short period, sometimes two weeks, that the whole process seems incredible, even to the initiated. In other cases, the pain, hemorrhages, and foul discharged cease, and the part cicatrizes and leaves a soft, yielding scar, without contraction, deformity or unsightliness. Sometimes regression to a marked degree is secured, and the case progresses no further. This fibrosis of the neoplasms may be allowed to remain inactive or be excised and the wound rayed or not as conditions indicate. Again inoperable tumors may undergo sufficient regression to permit ready removal, and thus bring the patient into good condition.

"In diseases of the urologic system the remedy is of service, especially in the milder forms of cancer, as the papillary variety of the bladder; and acts well frequently in those extensively attached growths for which no operation is indicated, except extirpation of the bladder and transplantation of the ureters in the loins, the abdomen, the vagina, or hollow viscera for drainage. In such cases large dosage must be employed. The squamous cell variety of the disease is very obstinate here as everywhere; and a guarded prognosis must be given if this pathologic variety is known to be present. Large dosage must be employed in this condition if any hope of benefit of the patient is entertained; this must be accomplished by abundant screenage. A suprapubic cystotomy may be necessary or the brass tubes enclosed in a catheter or rubber tube may be used in women. In men the catheter alone may be employed. A number of cystoscopic instruments have

been devised, but they do not carry dosage enough to reach these widespread carcinomata. A word of caution here should be given, for if too much dosage at too frequent intervals is used, the case may be aggravated by undue radiation or a condition developed which resembles concentric hypertrophy of the bladder. Where the growth can be palpated needles may be employed from any convenient surface by the use of either local or gas anesthesia. Various forms of ulcers and hemorrhages of the bladder are favorable conditions to treat.

"The management of hyperplasia and cancer of the prostate is fast coming into the field of radium-therapy; and a number of cases of cancer of this organ have been clinically cured and remain well after several years. Hypertrophy of the prostate by urethral, rectal and needle applications is yielding to the newer methods and many cures are reported. The patients are not obliged to give up their business pursuits for more than a few days at a time and the treatment is gaining in popularity.

"Prophylaxis by radium has a large and increasing field of usefulness, in diseases both of the skin and mucous membranes.

"Many diseases of the cutaneous and urologic systems like rhinophyma, keratosis and many other diseases are fast coming into the field of radiosurgical therapy. I am convinced that the former malady, particularly, is better treated by radium than the knife.

"Up to the present we have rarely refused treatment to any unless they were actually moribund and in rare instances we have secured clinical cures in some of these, and foul discharges, hemorrhages and excruciating pain have been relieved in most of the others. Nevertheless the treatment of such cases is an injury to radium therapy as the vast majority of such patients must eventually succumb; then their cases are heralded as examples of the inefficiency of radium. Surgery rightfully does not accept such risks, and now, as we better understand the limitations of radium, we should be more careful in the selection of our cases. Perhaps we should not treat hopeless cases at all, for no matter how carefully we warn them that our efforts are expected to be palliative only, they, and their friends are likely to gain the impression somehow that cures are intended. Could we conscientiously adopt even approximated the methods employed in surgery and refuse hopeless cases, many other thousands of pitiable sufferers would be rescued from the grave annually."

Cancer of the Prostate. A Combined Surgical and Radium Method of Treatment.

R. H. Herbst, J. A. M. A., 72: 1610, 1919.

In 1915 Barringer described a method of treating cancer of the prostate by introducing a single needle containing radium through the tissues of the perineum into the tumor mass. The author presents a modification of this principle.

While many excellent results have been obtained with radium in the treatment of superficial cancers, the results in the deeper seated neoplasms have not been very encouraging, owing largely to the difficulty of bringing the radium directly into contact with the involved areas. It is the author's belief that this is accomplished in cancer of

the prostate by exposing the tumor both above and below and by inserting multiple needles, containing radium, in different directions, thus bringing the radium into contact with the most remote parts of the growth.

Method of treatment.—A suprapubic cystotomy is made (usually under local anesthesia), with a liberal opening in the bladder wall so as to give easy access to the involved bladder neck, because in practically all these cases the tumor is fixed and cannot be pushed up into the bladder. A bimanual examination is then made to determine the limits of the tumor. By means of a needle carrier, gold needles 1 inch in length, each containing 12 mg. of radium, are inserted into the tumor mass 1 cm. apart in different directions. The tumor is virtually converted into a pin cushion. A silk guide, which is attached to each needle, is brought out of the suprapubic wound, and by means of it the needle is withdrawn. These needles are left in place for from twelve to fifteen hours, depending on how much of an exposure is desired. They are readily removed by traction on the silk guides. One such exposure will usually cause the removal of most of the upper part of the tumor, although this can be repeated after a few weeks if found necessary. As most of the tumors begin in the lower part of the gland, a second introduction of needles is made into this part of the tumor by making a dissection through the perineum and obtaining a complete exposure of the lower part of the prostatic mass. It is well to allow from four to six weeks to elapse between the two steps of the operation. It may be readily seen that by this open method we are able to insert the unscreened radium directly into all parts of the tumor, and the action of the radium takes place in the center of the carcinomatous nodules. There is little reaction or pain following even long exposure. It is well to make the upper exposure first, because following the introduction of the radium a temporary swelling occurs, which is likely to cause complete retention, should the lower application be made first.

Recent Progress in Treatment of Cancer of the Prostate, Seminal Glands and Bladder.

H. H. Young; So. M. J., 11: 120, 1918.

Radium, applied through the rectum, urethra and bladder, offers great benefit in extensive cases of cancer of the prostate and seminal vesicles. Hope of radical cure is not impossible.

Early cancer of the bladder at the base is effectively treated by radium with the aid of three new cystoscopic instruments designed by the author and described in this article. The radium capsule may, under direct cystoscopic vision, be placed accurately on the bladder tumor.

For treatments per rectum the cystoscope is not necessary and a smaller instrument has been constructed, which carries the radium in its beak. By means of a finger in the rectum, the capsule of radium, with this instrument, may be placed at any desired spot against the posterior surface of prostate, seminal vesicles or bladder. The mechanical holder (which clamps upon the ball near the end of the instrument) holds the instrument where desired. Using 103 mg. of radium in a

platinum capsule, the author found that from 20 to 30 treatments of an hour each, may be given to the prostate and seminal vesicles, per rectum, without producing more than slight irritation in most cases, if the location of application is different each time. Positions about 5 to 10 mm. apart are selected. In some cases they overlap, but as a rule from 2 to 4 weeks elapse between the two overlapping treatments. The treatments are given, usually every other day.

Vesicle papillomata have a great tendency to malignancy and should have radium applied to their bases after destruction with fulguration.

Chronic Interstitial Nephritis: An Apparently Hopeless Case, Benefited by Treatment with the Emanations of Radium and Thorium.

F. E. Park; N. Y. M. J., 104: 66, July 8, 1916.

Case: Patient was first seen by the author Oct., 1914. "On examination, I found a woman of 62 years, fairly well nourished; color poor; tongue coated; slight degree of anascarca present. She was very weak and unable to assist herself." There was a mitral murmur of the heart. Pulse 120 and blood pressure, systolic, was 240 mm. Hg. The urine was pale, specific gravity 1.010, with slight trace of albumin. Digestion was impaired, there being much fermentation, and she had a great deal of gas. She complained very much of pressure in the head and ringing sound in the ears.

The treatment consisted of radium emanations in the form of drinking water and injections intravenously. She also wore a pad over her heart. She was also given 30 c.c. of the radioactive plasma (Quinton) daily. After the first week she began to show signs of improvement. Up to that time she had been too weak to feed herself. The appetite began to come and there was a steady change in the urine. At the end of eight weeks she was eating a variety of things and walking about the room. By January the urine was practically normal, also the heart, except when under some excitement, and she began walking outdoors a little. By February she was walking every morning half a mile on the sidewalk in front of the sanatorium, and her pulse was constant at 72, while the murmur was not to be heard. She discontinued treatment and returned to her home. A year later there was still improvement.

The author states, "Judging from a two years' large experience in this field, I venture to predict that the day will come when it will be a customary thing as middle age is reached, regularly to take a course of radium treatment in order to revive and stimulate the functions of the whole body and put back by appreciable years the inevitable decline which we call old age."

The Technic of Radium Treatment per Urethram in Prostatic Carcinoma.

J. Cauhapé, Internat. Clin., 1: 200, 1916.

Before commencing radium therapy, a methodical examination should be made of the urethra and bladder, which will give all neces-

sary indications for whatever preliminary treatment may be required so that the radium therapy may be carried out successfully. The patient, being relieved of his functional disturbances, voids his urine freely, and vesical tenesmus is overcome; in other words, all vesical irritability disappears, so that he will have a greater tolerance for the radium catheter and can support applications of long duration.

The ordinary aseptic measures are to be resorted to in the application of the treatment: cleansing of the glans penis, asepsis of the anterior urethra by irrigation with a solution of boracic acid or oxycyanide of mercury 1 in 4000.

If spontaneous micturition does not previously exist, if there is a marked amount of residual urine, if the bladder has not been kept empty by suprapubic drainage, the viscus should be emptied by the catheter, this being followed by an antiseptic irrigation given through the catheter, the latter being progressively withdrawn.

When the patient experiences difficulty from the contact of the instrument, a few drops of a solution of stovaine should be injected, so as to produce at least a partial anaesthesia of the urethral mucosa, before passing the instrument. This practice should be resorted to only in very timid patients or those who really suffer, because it deprives the operator of the important indications furnished by the special sensibility of the urethra. With a complete local anaesthesia the radioferous tube may be improperly placed or the physiological limits of the tolerance of the tissues in respect to the radiations may be exceeded. Such accidents, however, can only occur in inexperienced hands.

As to the apparatus, a silver tube with walls half a millimetre thick should be selected, directly containing from 5 to 50 milligrams of radium sulphate. The tubes devised by Wickham and Degrais in the treatment of prostatic cancer have walls three-tenths of a millimetre thick and contain, according to the case, 1, 2 or 5 centigrammes of radium sulphate.

The patient being in the recumbent position, the pelvis slightly elevated and the legs flexed on the thighs and the thighs on the pelvis, a tube usually containing 5 centigrammes of the radium salt is carried to the prostatic urethra. To accomplish this, the radioferous tube, provided with a metallic thread attached to the eye on the plug which closes the tube, is introduced into an elbow catheter down as far as the first eye, but without going beyond it. It is fixed in this position by rolling the remainder of the metallic thread which passes out of the pavilion of the catheter around the end of the instrument.

Thus arranged, the instrument is passed into the urethra according to the ordinary rules of catheterization. In order to place the tube exactly in the prostatic urethra it is absolutely necessary that the tube shall not exactly fill the lumen of the catheter, and that the lumen of the latter should remain sufficiently patent so as to allow the free flow of the vesical fluid.

The proper placing of the tube is accomplished in exactly the same way as that of a catheter à demeure. With a little practice and careful manipulation one will always be able to place the instrument at the "drop by drop" point, as the urologic expression goes, and at this point the eye, near which is the tube, exactly attains the neck of the bladder.

No matter what displacements one may then give to the catheter,

whether in the desire to act in the prostatic urethra, the neck or in the cavity of the bladder, by following the method of placing the instrument here described a sure landmark for localizing the exact situation of the radioferous tube will be had. Dr. Minet has utilized, for intra-urethral applications of radium, an elbow gum catheter, the beak of which is hollowed out so as to receive the radium tube, this being screwed on to the instrument and having a lateral eye to assure the emptying of the bladder in case endovesical applications are to be made along with those of the prostatic urethra in cases in which it is indicated to act on the prostatic growth of the bladder walls or simply to treat a malignant neoplasm arising in the latter organ.

Although this catheter is ingenious in construction, it does not appear to be more useful than the ordinary elbow catheter containing the silver tube as above described, and which, at least in applications in the prostatic urethra, should be the instrument of choice. Instead of the ordinary elbow catheter, one might perhaps advantageously substitute an elbow catheter having a single eye placed at the bend, but this would not make any change in the technic to be followed.

And in respect to this, Dr. Pasteau very properly points out that it is absolutely necessary to introduce and fix the tube in the catheter before any attempt at catheterization is made, because once the catheter is introduced it would be quite impossible to push the radium tube down into place, as it would be caught at the bend of the instrument and therefore could not pass beyond the membranous urethra.

It occasionally happens that the catheter, with the tube within, is passed with some difficulty, producing rather sharp pain in the deep urethra. This is due to a too great rigidity given to the instrument by the tube, and in order to avoid this Wickham and Degrais have used, instead of a single tube, two tubes half the length of the single one, placed one above the other in the catheter, so that they make a sort of joint which allows the easy passage of the instrument over any obstacle in the urethra. In other words, it is a great advantage to employ two silver tubes 15 millimeters long, each containing 25 milligrams of the radium salt, instead of the 35-millimeter tube with 5 centigrams of radium.

When the instrument has been placed in proper position, it is necessary to retain it in this situation and avoid any displacement. For this purpose one may use Escat's instrument, which is an elastic band placed around the base of the glans, to which are attached some small wire arcs connected with a ring attached to the catheter, a few millimeters from the meatus. The other ordinary devices may also be employed, but the simplest is to fix the catheter to the pubic hair by double cotton threads, tied to the catheter very near the meatus. The two ends, on each side, are united by a knot at the base of the glans. They then are passed respectively above and below the penis, to be again knotted on the lateral aspect of the organ, after which they are tied to a tuft of pubic hair.

In the technic the totality of the gamma rays and a variable proportion of the beta radiations are utilized. The latter, being animated with a greater rapidity, are, consequently, endowed with a greater power of penetration, but the walls of the catheter prevent the unfor-

tunate secondary accidents, so that it is possible to prolong the duration of the applications so long as desired.

It follows, from the well-known value and efficiency of these incomplete radiations in deep-seated regions of the body, such as the esophagus and prostatic urethra, that one should allow the instrument to remain in contact with the tissues as long as possible, and always in inverse proportion to the radio-active intensity. It should here be recalled that, in order to eliminate all danger in long applications, it is necessary that the walls of the catheter shall form a complete screen around the surface of radiation of the tube, which must never be seen at the eye of the catheter.

The author then summarizes the rules for radium therapy of prostatic carcinoma. Every third day the catheter, with its radium tube or tubes as described, is introduced into the prostatic urethra and fixed in place for two hours. The total number of applications being six, represents twelve hours of radium application for each case. The treatment may be renewed according to the therapeutic results obtained.

Following each seance, after the catheter has been withdrawn, a urethral irrigation may be given if considered indicated.

A urethroscopic and cystoscopic examination should be made from time to time in order to study the changes which have taken place. Instillations of silver nitrate and irrigations with the same substance in 1:1000 solution may sometimes be employed with advantage in the interval of the applications.

The unsatisfactory results obtained by very radical operations., such as Young's, in prostatic carcinoma, have convinced the author that radium therapy is indicated in many cases, as the results so far have been very encouraging and satisfactory. The six cases in which this treatment has been employed and which the author has followed, show encouraging results; in fact, much better than those obtained by a radical operation.

Radium Therapy in Urology.

H. Schüller, Wien klin. Woch., 27: 122, 1914.

Stenosis of the urethra through keloid proliferations, tumors of the prostate, vesicopapilloma or sarcoma, are all indications for radium therapy. Although some tumors do not respond to ray exposure, it is indicated whenever an operation is impossible, especially since the healthy vesic and rectal mucous membrane is not easily injured by the rays.

As to the technique, a gradual increase to the maximum dose was obtained as follows: 60 mg. radium bromide in a small tube 1 cm. by 4 mm., filtered through 1½ mm. platinum-silver for 36 hours was applied endovesically without any signs of irritation; 100 mg. radium bromide filtered through 2 mm. gold and 2 mm. gum then applied rectally for 24 hours. Bladder and rectal tissue is relatively very resistant towards radium; in only one case did marked proctitis set in.

In three cases of callous cicatricial stenosis of the urethra the effect of exposure to the rays was very satisfactory; similarly in two out of nine cases of gonorrheal stenosis. Those cases are refractory in which no cicatricial proliferations are present. Mild hypertrophy

of the prostate may be treated by radium rays as long as it is not a fibrous, adenomatous proliferation. From eleven cases, three cases were decidedly successful, and one surprisingly successful.

Out of five cases of non-operable cases of incipient carcinoma of the prostate, two were not affected; one was seen to be healed; in another the pain was relieved in two or three weeks and the progress of the disease stopped; in the last the ulceration increased. Out of seven inoperable cases, one was entirely healed; in two the size of the tumor was diminished; three remained unimproved and one case became worse with the appearance of a severe vesical hemorrhage.

One case of frequently relapsing multiple vesico-papilloma was cured completely to date. In carcinoma of the bladder, those in women are more accessible to treatment than those in men.

Radium Therapy in Cancer of the Prostate.

H. C. Bumpus, M. Clin. N. Am., 3:707, Nov., 1919.

After a short, concise history of the various methods that were used for the application of radium in carcinoma of the prostate since this kind of treatment was first instituted, the author comes down to his own method of application.

He uses four needles, the combined strength of which is about 50 mg. These are inserted through the perineum, two on each side of the mid-line, and allowed to remain in the gland about twelve hours. Before the needles are applied, the field of operation is anesthetized. After the skin has been infiltrated, the hypodermic needle is thrust deep in, close to the inner margin of the spin of the ischium, and the pudic nerve is infiltrated.

This nerve supplies the greater portion of the perineum, and on the ability to anesthetize it successfully depends not alone the ease of procedure in accurately applying the needles, but also the patient's complete freedom from pain. After allowing time for complete anesthesia, the left forefinger is inserted in the rectum and the general contour of the growth ascertained. With the right hand the needles are then plunged through the perineum in a downward direction until their tips are felt through the rectal mucosa, when, by a slight upward thrust they are made to enter the gland substance at the desired points. Safety-pins are placed through the eyes of the inserted needles to insure against their loss under the skin. An opium and belladonna suppository is inserted to allay any subsequent discomfort as the cocain wears off, and the patient is placed in bed in the usual position. The needles are left in position for approximately twelve hours, giving a dosage of about 600 mg. hours.

After the localized reaction due to the insertion of the needles has subsided the patient is given rectal treatment. This consists in applying a 50 mg. tube of radium directly over the prostate. As an applicator, the author uses a piece of sheet lead cut in the shape of a spoon. The small metal container holding the radium is placed in the bowl and the lead is bent over three sides of it. Over this a brass tube is slipped to filter the beta rays on the exposed side; the rectal mucosa is, therefore, screened by lead on all sides except directly over

the prostatic area, and there the irritating rays are filtered out by the brass tube. After the applicator is inserted and placed in the desired position, with the open side of the bowl next to the prostate, the handle is bent at right angles and attached to the thighs or buttocks by surgeon's plaster. This method allows the patient to move about freely while recumbent and while the applicator is still in position, thus doing away with the discomfort necessitated by remaining on an examining table to which a rigid mechanical arm is attached. The radium is left in position for a time sufficient to assure a total dosage of 200 mg. hours. When it is possible to do so without causing trauma in cases in which the growth has not obstructed the urethra the patient is also given 200 mg. hours in the prostatic urethra, the radium being inserted by means of a soft-rubber catheter; the gland receives in all 1000 mg. hours.

SECTION X

RADIUM—ITS UNUSUAL USES

- A. Rare Cases
- B. Nerves
- C. Gout and Rheumatism
- D. Brain Conditions, Etc.

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The Action of Radium on Tumors of the Bone.

I. Levin, Med. Rec., 100: 673, 1921.

The writer has shown in a previous publication that in skeletal metastasis of carcinoma the two reactive processes within the bone, the osteoporosis and the osteosclerosis, are frequently present alongside, near the same tumor. Usually the osteosclerosis is very imperfect, the metastatic nodule increases in size, suppresses the power of the organism to create new bone, and progressively destroys the old bone. The spontaneous healing power of the organism is thus quite imperfect.

The writer has demonstrated on a series of cases that radium and roentgen therapy may enhance the healing power of the organism, destroy at least a major part of the malignant tumor, and surround it with newly formed bone. The following two cases, which have not been previously published, may further illustrate the mechanism of the action of radium on malignant tumors of the skeleton.

Case 1.—Mrs. F., 54 years of age, consulted Dr. Willy Meyer for carcinoma of the left breast. In the course of the examination there developed a pathological fracture in the middle of the shaft of the right humerus. Roentgenogram showed complete destruction of bone of the diaphysis of the humerus in an area over one inch long. There was no clear evidence of skeletal metastases elsewhere. In view of the fact that Dr. Meyer was acquainted with the writer's results in radiotherapy of skeletal metastases and the condition in the breast was operable, he decided to do a radical removal of the breast and refer the patient to the writer for the treatment of the fracture. The method of treatment consisted in covering the fractured area with three packs of tubes of radium emanation. One pack was placed over the anterior surface, the other over the external and the third over the internal surface of the humerus. In all 208.9 millicuries of radium emanation were applied for sixteen hours. The emanations were filtered with $\frac{3}{4}$ mm. of silver, 2 mm. of brass, 1 mm. of leather and about 2 inches of gauze. The splints were applied over the radium packs to retain the correct position of the bone. One week later a similar application was made for sixteen hours of 249.1 millicuries. The following week, or two weeks, after the first radium application, a roentgenogram showed a callus formation and the ends of the bone in good position. The patient could support her arm without splints. Such a prompt formation of a functionally perfect callus in a pathological fracture which on the first roentgenogram did not show the least tendency to osteosclerosis indicates that radium therapy must be an efficient agent

in many diseases of the skeleton in which osteosclerosis could neutralize the pathological process.

Case 2.—Mrs. G., age 24, consulted the writer in 1920 for a tumor in the region of the upper third of the right tibia. The roentgenogram shows a defect in the upper third of the tibia of an area about two inches long and one inch wide. The patient refused an amputation. The writer then excised the tumor, which invaded the muscles, and excochleated the bone to such an extent that only a thin shell of the outer wall of the compact bone of the tibia remained. A cavity was thus formed in the bone about two and one-half inches long into which was placed a specially constructed brass box containing a series of radium emanation tubes, 213.0 millicuries in all, and left for sixteen hours. This was followed by several applications of radium packs over the operative field. A roentgenogram taken twelve months later showed the cavity filled with compact bone. Palpation also failed to detect the cavity which was formerly present in the bone.

The analysis of these two cases, as well as of all the previous cases reported by the writer, indicates that radium causes a very rapid formation of new bone. The callus in Case 1 formed more rapidly than it would have formed in a traumatic fracture without the aid of the radium. It seems feasible to suppose *a priori* that radium therapy may also hasten callus formation in fracture and increase the success of bone implantations. In fact, Knox claims to have used x-rays in cases in which bone grafts have been used in the restorative operations.

The analysis of Case 2, as well as of the sarcoma cases previously reported, clearly indicates that similar results may be obtained in other pathological processes of the skeleton. Multiple myeloma of the bone is more akin to lymphosarcoma than to true sarcoma, or carcinoma, and must therefore be more radiosensitive than the latter conditions. Chronic inflammatory diseases of the skeleton, osteitis or osteomyelitis, present frequently pathological pictures very similar to those of sarcomata of the bone. It is very difficult, for instance, to distinguish between a giant cell sarcoma and a so-called hemorrhagic osteomyelitis. Moreover, the writer has previously shown that the action of the radium and roentgen rays on tumors and on infectious granulomata is quite analogous. It is plausible to expect then that if a focus of chronic osteomyelitis were prepared surgically in the same manner as it was done by the writer in Case 2, and then treated with radium, a satisfactory clinical result may be obtained.

Radium Treatment of Vulval Vegetations in the Course of Pregnancy.

P. Degrais, Gynéc. et obst., 4: 493, Nov., 1921.

Although vulval vegetations are relatively unimportant in themselves, the asepsis of the genital zone at the time of labor is made difficult by them. As radium applications are painless, do not produce any reaction, and cause a rapid disappearance of the vegetations, their use can be strongly recommended. For vulval vegetations Degrais recommends the use of varnish apparatus in spite of the fact that these

have fallen into disfavor because their beta rays are not partly absorbed as is the case with tubes and needles, and these rays are wrongly considered as useless or dangerous. As a matter of fact, vegetating lesions of the skin are more sensitive to the total radiation of radium. An apparatus 4 cm. square and containing 10 mg. radium bromid is applied for forty-five or sixty minutes. When the vegetation has a wide base of implantation, or when there is cicatricial tissue as the result of previous caustic treatment, it is better to filter slightly. In this way the application may be prolonged without fear of a reaction (lead filter 0.1 mm. thick, length of application, three to five hours). Healthy skin between vegetations should be protected with lead 0.5 mm. thick. For vaginal vegetations the author uses tubes of platinum having walls 0.3 mm. thick and containing 25 mg. radium bromid. One or two applications lasting eight hours in all are made. Three or four weeks after this treatment, the vegetations completely disappear and the genital region becomes normal again.

Effects of Radium Emanations upon Brain Tumors.

C. H. Frazier, *Surg. Gynec. Obst.*, 31:236, 1920.

Because the rate of growth is surprisingly slow, because brain tumors are often inaccessible or unlocalizable, because they do not metastasize but continue until the end confined to the original focus, because they are often not directly but only indirectly responsible for the subject's death, because technical difficulties interfere with their radical removal, there is a field for some physical agency, which will not only arrest the growth of the malignant lesion, but even lead to a process of retrogression. It was with this thought in mind that in 1914 the author secured by gift for the University Hospital 125 milligrams of radium and deposited it in the care and at the disposal of Dr. Henry K. Pancoast. Since that time, radium has been applied in his clinic under the direction of Dr. Pancoast in the treatment of brain tumors in 24 cases, and from these he has selected 3 cases as illustrations of what radium may accomplish. In these there seems to be indisputable evidence that by radium emanations the growth of the tumor has been arrested and in all probability the tumor destroyed.

Case 1.—In 1914, an inoperable tumor of the pontile angle was found at operation. At the time the patient was stuporous and totally incapacitated. Eighty-five milligrams of radium were implanted in tumor for fifteen hours. Six weeks later improvement was first noted; 4 months later the patient was ambulant. Six years after the first treatment the patient is living and while symptoms of cerebellar disturbance have not disappeared, the condition is now stationary.

It is perhaps too soon to make a final report on this case. There is no doubt that the effect of the first treatment was very extraordinary. The patient was *in extremis* and it was not thought he would survive more than a few days or weeks at the most. The tumor was of large dimensions, with ample exposure on the operating table, but quite inoperable. That the patient should have been transformed from a bed-ridden and stuporous condition to an ambulant state would seem to

admit of but one interpretation. That there is evidence still of disturbance of cerebellar function may be accounted for on the grounds of permanent damage to the cerebellar tissue by the growth before the treatment was begun. This view is further substantiated by the fact that since the second application the condition appears to be stationary.

Case 2.—Child with evidences of serious disturbances of cerebellar function, chiefly left. Unable to stand or sit, difficulty in talking and swallowing, marked adiadokokinesis, hypermetrv, vertigo, headache, nausea and vomiting, and postpapillitic atrophy. Following suboccipital decompression and serial application of radium, there was an extraordinary improvement in every particular so that 8 years after first observation the child has been restored to almost perfect health.

The outcome in this case has been more striking than in Case 1, in that vision has been conserved at least in one eye and the residual signs of cerebellar disturbance are but trifling as compared with the original state. There is, however, in this case a link of evidence missing in that the tumor was not exposed on the operating table. However, the clinical picture would seem to admit of but one interpretation. Viewing the case in the light of a therapeutic achievement, the results 7 years after the first treatment have been, to say the least, extraordinarily gratifying.

Case 3.—Recurrence of headaches and visual disturbances 19 months after a sella decompression. Following a course of glandular feeding, x-ray and radium therapy there was a disappearance of scotomata, restoration of normal vision, and reestablishment of menstruation. There was no recurrence 3 years after treatment was instituted.

The return of normal vision and the abatement of one of the evidences of pituitary disturbance — amenorrhea — were the two striking results of treatment in this case. Either of them would have been sufficient to convince one that the structure of the pituitary had been decisively influenced; otherwise (after the relapse which followed a year after the operation), vision would not have been restored nor menstruation reestablished. There is to be considered in this case, however, the fact that both radium and x-rays were used and to each must be accredited a share in the results. So far as the author knows this is the first case in which the radium was applied to the pituitary body, as Dr. Pfahler directed, through the posterior nares.

The author concludes as follows: "My purpose in this brief note is to call attention to the possible achievements of radium emanations in a field that offers many opportunities. I must speak very guardedly in order not to be misleading. I offer in evidence three cases of brain tumor where the growth of the tumor, in the light of the clinical evidence, has been arrested at least, the tumor possibly destroyed, in periods of observation covering a maximum of eight years."

Radium Emanation in Hay Fever.

F. E. Park, Med. Rec., 93: 284, 1918.

The author has successfully treated two cases of hay-fever with

radium emanation. One case he cured accidentally. A patient, of very nervous temperament and in a generally run-down condition due to business strain, came for treatment. This man had always been well except for an annual attack of hay fever. He was given a six weeks' treatment with radium emanation and discharged in good condition. He had no attacks of hay fever for three years after that, when he came back for treatment of his old trouble, the hay-fever. He received the same course of treatment as previously, and inside a week there was complete relief of all symptoms. The treatment was continued for two weeks longer, when he was discharged and had no further trouble during the rest of the season.

Having had such success with his first case, he tried it purposely the second time. This patient was a middle-aged, overworked woman who had had hay fever attacks of maximum severity for thirty years back with no intermission. She came to the author's notice two weeks before the usual date of the beginning of her attacks. He proposed trying to get a prophylactic result with a course of radium emanation. This was done and the treatment was extended over a period of four weeks. As a result she passed through her first summer and autumn with no hay fever, becoming so bold finally as to weed in her garden and deliberately expose herself to the same influences that had formerly affected her.

The Use of Plastic and Elastic Fixation—Prothesis in Radium Therapy.

L. Edling, Münch. med. Woch., 64:417, March 27, 1917.

By means of a plastic material, hardened however at body heat, it is possible to fix radium in the correct spot and thus eliminate the difficulties in the treatment of oral cavity, nasopharynx, etc., with radium. So-called "casting material" (Abgussmasse) which dentists use for making casts of teeth, gums, etc., was used since at 40°-50° C.; it is very plastic. This may be used for casting tumors, ulcerations, mucous membranes, etc. The slightest unevenness would be modelled and hence each part of the tumor could be recognized, and the radium apparatus adapted to it. The substance itself may be used as a filter, or a metallic filter added. In treating the surface of the skin glycerogelatine oxide of zinc was used as the fixing material.

Radium in Gastric Carcinoma.

C. E. Field, N. Y. M. J., 102:1171, 1916.

"The increasing frequency of gastric carcinoma and its tremendous mortality make it a subject of great importance. Surgical treatment, following early diagnosis, presents most encouraging results, but early cases are few and far between. In advanced cases, surgical interference is not evolving treatments which promise radical advantage, and we must search for relief along other channels. I am frank in saying that we are not able to present satisfactory results in gastric carcinoma from the use of radium, although many have attempted to give treatment in various ways. Special applicators of silver and rubber with handles

suitable for introduction have been used, but the inability definitely to locate the mass and give proper application is sufficient reason for the fact that there is but little literature.

"When we review the subject and note the surprising lack of evidence, we are constrained to ask, Has radium any place in the treatment of gastric carcinoma other than purely experimental? Judging, first by the results that are evidenced from application of radium in the urinary bladder; secondly, by the opportunity for application in cases where exploratory incision for diagnosis is to be made; and, thirdly, in using it for the relief of pain in inoperable cases, I should not only say that radium has reason for active consideration, but I feel confident that it will not be long before encouraging findings follow an improved technic.

"Undoubtedly, the fear of producing radium burns and the consequent danger of perforation have deterred many from attempting treatment. Furthermore, the lack of suitable means of introducing under the field of vision an applicator containing radium of sufficient potency and maintaining it in proper position for an hour or more, have been deterrent features. The gastroscope may come into play, but even in the hands of so talented an operator as Chevalier Jackson, it has been hardly possible to secure application by such means. Many esophageal cases are treated with success, but not so growths at various portions of the gastric wall.

"In the urinary bladder, Dr. Winfield Ayres, of New York, has been giving treatments with radium that are promising. By means of a gold screen applicator attached to a flexible silver wire, constructed in such a manner as to permit it to gain access through the cystoscope, he is able to make application directly to a cancer mass which is in direct vision, and give a dose of 200 milligram hours at a time. Careful regulation of the dose, combined with experienced technic, gives assurance of no bad effects and much to be expected. Dr. Hugh Young, of Baltimore, has devised many new types of radium applicators for bladder work and commonly uses very high doses.

"With the stomach, we hope that some device will be presented in the immediate future to give us the same possibility of application that is afforded in the bladder. Einhorn, of New York, some time ago, employed a radium gastric applicator, called the radiodiaphane, which was simply a radium tipped applicator, which carried a rubber tube and permitted gastric distention by means of a hand bulb. This instrument was used in numerous instances, but for the most part was reported as unsuccessful.

"Dr. Robert Coleman Kemp, of Fordham University, has given us a new instrument known as an inflating gastroscope, which will have advantages where operation for diagnosis or treatment is decided upon. It certainly would serve as a most practical means of making a direct initial application of radium. In some cases it might be advisable to create an abdominal fistula for continuing treatments. In such an instance it is possible to use a smaller calibre instrument. The Kemp apparatus is certainly a step in the right direction, although I am of the opinion that its author had little thought of advancing it as a means of administering radium therapy.

"That the world is not standing still as far as effort is concerned, is shown by the fact that von Czerny, of Heidelberg, has reported observations in several thousand gastric carcinoma cases. His experiences detail the direct application of radium, the use externally of radium compresses for relief of pain, and the injection of the soluble salts of radium. With the latter treatment, he avers that he has checked, for a time, active congestion, relieved pain, and reduced stenosis to the point of allowing the passage of food.

"Bissell, of New York, has reported palliative results from the intravenous injection of solutions of the soluble radium salts containing 100 micrograms of the element. Such means of treatment are plausible for the purpose attempted, and are rich in possibilities. Paul Ehrlich states that the application of antitoxins and serums had reached its zenith, and the next great step in therapy will be the employment of radium solutions combined with other curative agents (possibly colloids) yet to be announced. There are several research workers doing most interesting work along this line. Possibly, the complete destruction of cancer will not come until we can present treatment that can be administered directly through the body fluids.

"I regret exceedingly that it has been impossible for me to present more encouraging data, but in the light that is now mine I feel that progress is being made and that not many years are to elapse before our hopes will in liberal measure be realized."

Action of Radium Rays on Heart Action.

H. Zwaardemaker, C. E. Benjamins and T. P. Feenstra, Nederl. Tijdschr. v. Geneesk., 2: 1923, 1916.

The isolated frog heart beats on for a longer period after the heart cavity has been flushed with salt solution or Ringer's solution. The author observed that this solution contained a radio-active element, i. e. potassium; this is the only radio-active substance present in the animal organism. It seemed, therefore, of importance to ascertain if this potassium might be replaced by other non-organic radio-active substances, which contained the same degree of radio-activity. This proved to be possible with rubidium, uranium, thorium and radium; it seemed as if the radio-active elements in ionic form circulated free in the fluid and in this way entered the cellular tissues; when they are expelled the heart action ceases.

The cause of this effect must be oligodynamic as the gamma rays play no part. It was then attempted to obtain the same result with radium treatment through external raying (beta and gamma rays). Hamburger used for this purpose a decerebrized frog, whose heart was flushed with Ringer's solution. Exchanging this for a potassium-free solution resulted in cessation of the heart beat within thirty minutes.

The radium preparation was now placed within several cm. of the heart; the heart soon beat regularly once again. If the radium preparation was removed the pulsation ceased.

There are two kinds of perisystole: (1) resulting from lack of radioactivity; (2) resulting from superfluous radioactivity. They may

easily be differentiated in the following manner. The potassium free fluid from the rayed pulsating heart is exchanged for Ringer's solution. If the organ contained superfluous or merely sufficient radioactivity, the heart action ceases; if, however, the organ suffered a lack of radioactivity, the pulsations become more marked instantly. Thus a sufficiently rayed heart may be made to cease beating with Ringer's solution containing calcium or made to resume beating with Ringer's solution free from calcium. This sounds paradoxical. Calcium-free Ringer's solution produces very rapidly a cessation of the heart beat which raying does not affect.

There is, of course, a process in the internal heart quite independent of calcium deficit and simultaneous potassium compensation. This process, the secondary radioactivity, remains in the heart and governs its action. It is remarkable, however, that a potassium-free frog-heart is mechanically quite non-irritable, before resuming its action after raying.

A Study in the Internal Therapeutics of Radium.

Samuel Delano, N. Y. Med. Rec., 88: 137, July 24, 1915.

Radium emanation may be introduced in several ways, viz.: by injection, by inhalation, by bath, and in solution by drinking.

The author gives numerous case reports.

Case 5: Rheumatoid arthritis: M., aet. 72. All joints, especially hands and knees; distortion and increase in size; unable to sit down in a chair, dress himself, or go downstairs. First week sharp reaction; seventh day, "first good day"; in three weeks, after 36 micrograms radium and twelve radium baths, dressing himself every morning, coming downstairs alone, getting down in a chair and up, and going out. Marked diuretic effect, interfering with sleep; also excitant. Patient lost sight of.

Case 10: F., aet. 50. Wife of a physician; mild *arthritis deformans* (chronic progressive) of fingers; took 24 micrograms of radium without admitting benefit.

Case 27: Elderly woman with rheumatic arthritis, especially affecting neck, which was painful and offered difficulty in moving. Twenty-four micrograms radium over three weeks and radio-active earth effected much improvement according to both patient and doctor.

Case 40: Interstitial nephritis, marked arteriosclerosis: F., aet. 70. Chronic invalid for some years; confined to room; increasing edema of ankles; decreased amount of urine; very marked anemia. Under radium continuously for three months, about 190 micrograms being taken. There was the most remarkable improvement; edema disappeared; urine increased from fifteen to forty-five ounces, and maintained itself; great improvement in appetite, color and spirits. Urea also was measured and showed increase. The patient improved enough to go out riding. The radium was omitted for a couple of months. Patient had suddenly uremic convulsions with pulse of 150 of great irregularity, and complete suppression; she seemed about to die. Radium

was resumed cautiously and her condition rapidly improved. The doctor and the family paid the greatest tribute to the treatment.

Case 42: M., act. 12. Essential diabetes with accompanying parenchymatous inflammation of the kidneys. The patient was lethargic, moped, and it was for this that the radium was prescribed in the hope of getting a stimulant effect; it was an unqualified success, so that it was kept up for a couple of months. The effect on the sugar excretion was also appreciable; a quantitative analysis was not made, but the somewhat increased amount of urine was reduced to normal and the qualitative test was less marked. The patient was lost sight of.

"Radium can reduce blood pressure, but there was no opportunity for such specific applications of it. So likewise radium has marked effects on the blood picture, but no cases of pernicious anemia or leukemia offered themselves."

What can radium emanation do as revealed in this series?

1. *It is diuretic.* This is perhaps the most consistent single effect of radium. The ratio is perhaps in 7 out of 10 cases. This feature may be rather rapidly produced or show in any pronounced way only after three or four weeks.

2. *It is a laxative* — not so often as it is a diuretic, but in a large percentage of cases. This does not mean that it produces loose motions but only what seems ascribable to quickened peristalsis.

3. *It is a tonic and stimulant . . .* This tonic and stimulant effect, while not to be regarded as reflecting the most essential physiological activity of radium, is, nevertheless, a very important and satisfying exhibition.

4. *Metabolism and nutrition. . . .* There is much dispute as to radium in regard to increasing the nitrogenous metabolism . . . What radium does in the laboratory tube it would seem likely to repeat inside the body (which so often is not the case), because it is present in the system in the same unchanged form. . . . The effects of radium on nutrition of the skin seems very good. "Old skin brightens up and looks younger. . . ."

5. *External and topical.* Even a weak solution (2 micrograms to 2 ounces) is anodyne. It gives instant relief to toothache; this a dentist has confirmed in several instances.

Dosage: In making a radium salt from the basis of dosage, it must be borne in mind that the amount of emanation present is subject to a definite law — it cannot be more than the equilibrium quantity, which is a fixed constant. Quite otherwise is it with emanation per se — the amount of which present can be increased ad infinitum. The basis of comparison between a solution of a radium salt and a merely radio-active water (emanation) is quite unequal. . . .

In the preparations used in this series the maximum of emanation had already collected, and thus in association with 1 microgram of radium we have 1 microcurie of emanation, or 2,700 Maché units by measurement. . . .

The object being to introduce the emanation into the blood lodging it there by the immediate route of the vein, is, of course, the method par excellence; hypodermic or deep injections would come next, and

giving by the mouth last. Here, owing to the extreme diffusibility of the emanation, there is a considerable portion of it lost without passing into the systemic capillaries. . . .

Administering radium *per os* has perhaps one advantage, viz., its local action on stomach and digestive tract. The influence here is undoubtedly considerable and favorable.

Preliminary Report of Large Angiomatous Tumor on Baby, Treated by Radium.

D. T. Quigley, West. M. Rev., 20: 235, 1915.

A case is cited of a baby two weeks old, having an enormous tumor under the arm, which had doubled in size during the two weeks of the child's extra-uterine life, thereby threatening to become fatal.

Owing to the tender age of the baby, operation was considered out of the question. The danger of hemorrhage also made it impossible to bury radium in the mass. It was therefore decided to treat the tumor by cross-fire from the outside. In giving the treatment great care was exercised to avoid a dose in any place that might cause enough destruction of tissue to break into one of the blood vessels and thereby cause hemorrhage. The radium was used with a combination of distance and metal filtration and by the cross-fire method, nearly every night for three weeks. The dose was gauged somewhat according to the constitutional reaction and the amount used was from 15 milligrams to 125 milligrams of the radium salt.

The tumor began to shrink in size so rapidly that at the end of the first week it had gone down one inch in size. At the end of the third week it was about half the size it had been when treatment was begun. Baby still under treatment and condition satisfactory. The blood vessels that held the threat of hemorrhage have been destroyed, and if operation becomes necessary to remove the remains of the mass the author feels that it can be done safely.

The Use of Atrophan and Radium Emanation in the Treatment of Gout and the Arthritides.

A. F. Chace and M. A. Fine, J. A. M. A., 63: 945, Sept. 12, 1914.

In contraindication to gout, arthritis is not characterized by an excessive concentration of uric acid in the blood; and this difference, in the author's experience, has been of aid in distinguishing between these conditions. . . .

With regard to the influence of radium emanation on uric acid metabolism, various European workers have emphasized essentially two points: the increased elimination in the urine and the reduction or disappearance of uric acid of the blood. The increased elimination of uric acid in the urine under the influence of radium emanation is perhaps due to the induced leukocytosis with subsequent leukolysis.

"We have thus far treated thirteen cases of gout and arthritis in an emanatorium with radium emanation of 0.5 to 150 Maché units per liter of air in one to two hour sittings for one to two months; two

cases of arthritis with radium drinking-water; and five cases of arthritis with injections of radium bromid equivalent to 50-100 micrograms of the element. In no instance was there any change whatever in the uric acid concentration of the blood.

"With regard to clinical effects, we may say that in only two instances — those in which radium solutions were injected — did there appear to be any improvement. Here again, however, we feel that the treatment should be extended over a greater interval, before conclusions can be properly drawn with regard to clinical results."

Treatment of Brain Tumors by Radiation.

Henry K. Pancoast, Am. J. Roentgenol., 9:42, Jan., 1922.

Brain tumors are adapted to radiotherapy for several reasons: (1) In a large proportion of cases they are made up of malignant cells, and are, therefore, susceptible to radiation. (2) They are slow-growing and rarely metastasize. (3) It is permissible to remove part of the growth surgically and leave the rest for radiation. Pancoast's work has been based upon experimental observations of the effect of radium on the normal brain tissue of dogs, from which it has been concluded that on the human brain the surface dose of fairly well filtered radium concentrated over a small area should not exceed 1400 mg. hours, and had better be well below this amount. The safe dose from implantation is much smaller than the safe surface dose. In the case of tumors presumably completely removed by the surgeon, implantation is contra-indicated unless a large cavity persists and the radium can be packed in its center; otherwise the treatment should be by crossfire radiation, for which radiation radium is to be preferred. The scalp is marked off into squares of $1\frac{1}{4}$ inches, and each square exposed to 110 mg. radium in a lead box of the same inside dimensions, with the open end covered by 2 mm. aluminum and 5 ply thick rubber-dam filter, for one hour. In this way 30-50 squares are treated, as may be necessary, and the exposures, slightly reduced, can be repeated as soon as the skin reaction subsides. If the tumor has been only partly removed, or not at all, the radium can be implanted, as nearly as possible in the center of the tumor. Implantation should be supplemented by external cross-fire radiation. When the tumor is not localized or not found at operation dependence must be placed on general external cross-fire radiation. Implantation into pituitary growths exposed by the transsphenoidal route is not advised but the radium can be applied to the nasopharynx, and external cross-fire radiation used to supplement the application.

Pancoast reports 32 patients treated, of whom 18 are still living, from one to seven years after the first treatment. He believes that radiation has a decidedly beneficial effect and recommends the method.

SECTION XI
RADIUM—EXPERIMENTAL STUDIES

United States Radium Corporation
New York

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RADIUM—EXPERIMENTAL STUDIES

The Action of Radium on Transplanted Animal Tumors.

Francis Carter Wood and Frederick Prime, Jr., Strahlentherapie, 12: 1071, Berlin, Nov. 16, 1921.

In radiotherapy of tumors it is important to know the length of irradiation, the amount of radium element, and the distance between radium tube and tumor. When the majority of beta-rays has been eliminated by suitable filters, the action of radium is somewhat decreased, but the activity of gamma-rays is subject to the same general laws which govern the beta-rays. Sublethal irradiation retards the growth of tumor cells for some time; still shorter treatment appears to stimulate cell activity. At a distance of 1.1 mm. and using a filter of 0.4 mm. thickness, 100 mg. radium can destroy tumor cells in fifteen minutes, 83 mg. after one hour, 30 mg. after one and a half hours. No difference was noticed with any of the tumors treated. But when beta-rays had been filtered out, there was a great difference in the time required to destroy tumor cells. A 5 mm. filter paper was used in addition to 1.2 mm. brass; that is, the distance of the radium element from the tumor was about 6.9 mm. Extended experiments showed that 100 mg. and 83 mg. radium destroyed tumor cells only after seven hours.

These findings apply with fair accuracy to malignant tumors in human subjects. Beta-rays are extensively absorbed by 1 cm. depth of surrounding tissue; hence for deep irradiation only gamma-rays can be used, and the time of exposure is about 8 times as long as when beta-rays and gamma-rays are used. The action of radium rays on tumor cells in vivo is less distinct than that on isolated cell elements. This explains why an irradiation which will destroy a small metastatic bone in man may be inactive in the case of a primary vascular carcinoma.

The Effect of Radium Emanation on the Adult Mammalian Brain.

Halsey J. Bagg, Am. J. Roentgenol., 8: 536, Sept., 1921.

Bagg's experiments were primarily concerned with the histological changes following exposure of the adult brain to radiation from radium emanation and the extent to which the normal brain can be radiated without destroying normal functional activity, the unsatisfactory results obtained in surgical removal of brain tumors justifying the study of the treatment of such tumors by physical means. Experiments were carried out on rats, guinea-pigs, rabbits and dogs. Four methods were tested: (1) Radium emanation in minute glass tubes, without other filter, was placed permanently beneath the scalp in some instances and directly in the tumor in others. Each tube contained from 0.2 to 1.5 millicuries. (2) Larger doses of unfiltered radium emanation, 63 to 255 mc., were placed in the brain and left for various periods. (3) A comparatively large amount of radium emanation filtered through 1 mm. of platinum and contained in a capsule applicator was inserted in the

brain for thirty-five minutes. (4) Two large doses of heavily filtered radium emanation, 4,000 and 9,000 millicurie hours respectively, were given externally over the head. A still larger dose, 12,030 millicurie hours, was applied in a similar manner over the left temporal region of a monkey.

The author concludes that of the 4 methods the application of heavily filtered radium emanation over the scalp may be considered a relatively safe procedure for the treatment of brain tumors. The burying of small doses of unfiltered radium emanation (mainly beta-ray radiation) is also suggested as a favorable method of treating such growths. The relatively sudden destruction produced by comparatively large doses of unfiltered radium emanation makes this method unsafe. While the applicability of embedding filtered radium emanation is still uncertain, it is possible that by using still larger doses than were employed in these experiments, and decreasing the filtration, this method may also prove to be valuable.

It was noted that nerve tissue was markedly resistant to gamma-ray radiation; this reaction is probably associated with the relatively adult condition of the nerve cells. The changes in the brain following radiation were largely due to the destructive action of radium emanation on the blood vessels. There was a marked localized reaction, associated with a pronounced leukocytic infiltration, following the insertion of small doses of unfiltered radium emanation in the normal brain. These lesions were especially interesting, because of the absence of neurological symptoms.

In the case of the monkey that received a strong dose of heavily filtered radium emanation over the brain, there was no subsequent loss of previously established motor habits.

Experimental Research in the Action of Beta- and Gamma-Rays of Radium on the Tissues in Radiopuncture.

A. Lacassagne, J. de radiol. et d'électrol., 5: 160, Paris, April, 1921.

The advantages of intrastitial radium therapy are: (a) utilization of the total sphere of irradiation; (b) direct contact of the rays with the matter to be treated; (c) relative assurance against radio dermatitis. This technic has the one disadvantage of traumatic puncture of the tissue.

The replacing of radium by its product of disintegration, its emanation, by reducing the volume of the radio-active focus, permits of puncturing the neoplasm with only insignificant traumatism. The author reports a series of experiments as to the comparative value of elective radiation and of caustic diffuse radiation in the treatment of cancer. Taken individually each series of experiments confirms the theory that the lesion of necrosis increases with the initial strength of tube employed and the thickness of the screen.

The lesions provoked by intramuscular irradiation of the ovaries have the following characteristics: (1) They are elective. They affect certain follicles of the organ to the exclusion of others, such as the interstitial glands and yellow bodies. (2) Their extent is in proportion

to the strength of the dose administered. (3) They are independent of the degree of screening.

Elective action may be attributed to the tempered beta- and gamma-rays, caustic action to soft beta- and gamma-rays, although this subject is most complex.

In applying Curie therapy to cancer: (1) The radium puncture by means of screened needles is always to be preferred to naked tubes. (2) The power of the initial dose should never exceed a degree which would produce reactionary necrosis of the surrounding tissue. (3) It is important to obtain sufficient raying to sterilize a malignant tumor without causing tissue necrosis. (4) In applying radium through tubes of great intensity, the secondary screen should be at least as thick as the ray of the cylinder of necrosis.

The Response of the Animal Organism to Repeated Injections of an Active Deposit of Radium Emanation. Intravenous Injections in Dogs.

Halsey J. Bagg, J. Cancer Res., 5: 301, Oct., 1920.

The experiments reported were undertaken to determine the severity of the physiological reaction to intravenous or subcutaneous injections of an "active deposit" of radium emanation in dogs. It was found that large intravenous doses of an active deposit of radium emanation produced a considerable reduction in the number of white blood cells, as much as 80% of their total number, but that the simultaneous reduction in the number of red blood cells was less, amounting to only about 25%.

Repeated doses, amounting to a total of 338.4 millicuries distributed in four intravenous injections, apparently produced a very marked decrease in the number of circulating lymphocytes of the blood. Digestive disturbances, such as severe vomiting and diarrhea, occurred, as well as a considerable reduction in the body weight. In several cases, the body temperature rose following the treatments, possible because of an adaptive reaction on the part of the animal organism to the toxic condition produced by the sudden destruction of a considerable amount of cellular material. Daily urine analyses showed very decided increases in the total nitrogen content: the amount of urea, creatinin, uric acid, and total phosphates; while relatively small or moderate doses, if administered after the organism had already been injured by a previous injection, produced definite changes in the chemical content of the urine, indicative of destructive changes.

Microscopically, there was considerable congestion in the principal viscera. The liver showed general fatty and granular degeneration; the kidneys showed granular degeneration of the tubule cells; and the spleen presented considerable congestion, while the splenic pulp was largely drained of cells. The lymphoid tissue of the bone marrow was largely replaced by fat. There was extreme congestion in the pulp of the lymph-nodes in one animal, associated with a reduction in size of the lymph-follicles. The lungs in one animal were normal; while in the other, which received the larger total of the radio-active solution, they were congested and showed slight signs of emphysema.

The colon in one of the animals was markedly congested, and showed signs of active mucus production. The other organs showed no definite changes.

The author concludes that when the active deposit of radium emanation is used intravenously, as a therapeutic agent, great care should be taken to grade the dose in accordance with the general physical condition of the patient, which should be determined by frequent urine and blood analysis, and that if more than one dose is given during the treatment, the second dose should be made smaller in accordance with the strength of the original dose.

The Effect of Intravenous Injections of Active Deposit of Radium on Metabolism in the Dog.

Theis and Bagg, J. Biol. Chemistry, 41: 525, 1920.

The present work was carried on to study the effect of the active rays of radium upon the general metabolism of the dog. Solutions of sodium chloride which contained active deposit from radium emanation were used. To prepare the solutions, sodium chlorid is first dried and packed into a bulb and left in contact with radium emanation for three or four hours. The emanation is then pumped off and the salt dissolved in water in such concentration as to give a solution isotonic with the blood. The solution is drawn into a syringe and the amount of activity determined by a gamma-ray instrument. After the injection, the radio-activity remaining in the syringe is again determined and the amount injected computed by difference. The radio-activity is expressed in millicuries. It should be noted that the number of millicuries injected cannot be controlled exactly, as an irregular quantity (25 to 50%) will remain in the syringe. The rapid decay of the active deposit introduces a second source of error in estimating the quantity injected. Radium A decays completely within fifteen minutes after the preparation of the solutions. Since the injections were made after fifteen minutes, only Radium C need be taken into account. Radium C falls to 3% of its initial value within three hours, so that the physiological activity of the injected solution can last only a relatively short time. The physiological effects are presumably due to the alpha-radiation.

The first experiment was done on a Dalmatian dog. The first six days (Feb. 28 - March 5) serve as the control period before the first injection. On March 5 the dog received an intravenous injection of 95 millicuries of the active deposit. On the day of the injection there seemed to be no effects on the general condition of the animal, but on the two following days the dog had to be coaxed to eat the food and the feces were softer than usual. After this no further general effects were present. An examination of the nitrogen partition shows a sharp rise in the total nitrogen output, which reaches its maximum on the second day after the injection. This increased nitrogen is distributed among all the nitrogen constituents except creatinin. Ammonia increases proportionally more than does urea. Indeed the increase in the ammonia suggests a definite acidosis. The uric acid increases by about 50% over that of the preliminary period. It is possible that this is associated with the destruction of white blood corpuscles which fol-

lows the injection. Phosphates and urinary volume both tend to show definite increases over the preliminary period.

The total nitrogen remains high for five days after the injection, and then drops suddenly. The ammonia and particularly the uric acid drop more slowly. The latter does not reach the level of the preliminary period until twelve days after the injection.

On April 4th the dog received a second intravenous injection of 30 millicuries of the active deposit. This dose is scarcely a third of the quantity given in the preceding experiment. The total nitrogen again increases, and again the maximal figure is reached on the second day after the injection. The small dose employed in this experiment is followed by only a slight and transitory rise in uric acid. On the third and fourth days after the injection creatinin shows an increase well above the preliminary period.

On April 15 the dog received its third injection of the active deposit. On this day 42 millicuries were given. This injection is followed by a marked and prolonged effect. Total nitrogen, urea and ammonia increase and remain high for almost two weeks. Creatinin and uric acid both show a marked increase. The high figures for those constituents continue for about eight days after the injection. Throughout the series of treatments on this dog, there is a steady increase in the volume of urine eliminated. At first the amount was 200 c.c. and after the treatments it gradually rose to 1 liter.

On May 8 the animal received a fourth injection of 64 millicuries. This was followed by vomiting and refusal of most of the food for several days. The fact that the third and fourth injections were smaller in quantity than the first, and were followed by marked general effects, shows that the animal failed to recover completely from previous treatments with the emanation. Shortly after the fourth injection the animal was killed. Autopsy findings are not reported in this article.

In general, the results of the experiments on the second dog, a bull terrier, were about the same as the results on the Dalmatian. The effect of the injection seems to be cumulative, because the third treatment (first dog) only a little larger than the second injection, produced a very marked effect, while the fourth treatment, although smaller than the first, produced nausea.

Effect of Radium Rays upon Cane Sugar and Agar.

A. Fernau, Biochem. Ztschr., 102: 246, 1920.

Experiments conducted by Fernau upon a 2% aqueous solution of cane sugar prove that cane sugar is inverted by the action of the radium rays, either with or without the presence of platinum black as catalyzer. This inversion is a primary effect of the radium rays, and does not follow secondarily from the formation of hydrogen peroxide and the resulting acidity.

When a 1% aqueous solution of agar was subjected to radium ray bombardment the viscosity altered so that it almost equalled that of water, and the agar reduced Fehling's solution, indicating hydrolytic dissociation into, most probably, galactose and arabinose. Although hydrogen peroxide affects agar similarly the experiments with cane sugar suggest that this too may be a primary effect of the radium rays.

Results of the Exposure of Animal Ovaries to the Rays of Radium.

J. M. Maury, J. A. M. A., 74: 1711, 1920.

The experiments here recorded were made for the purpose of determining the changes brought about in the ovaries of rabbits by exposing them to 50 mg. of the element radium for twelve hours. This dosage was selected because it is that generally used in cases of so-called idiopathic uterine bleedings but which are now regarded as being due to an abnormal condition of ovarian secretion.

As some of these cases, particularly in young subjects, can be cured by the internal administration of pituitary extract, it is possible that not all of them are due entirely to ovarian conditions, some being due rather to a disturbance of the balance normally existing between the output of the pituitary gland and the ovaries.

It is well known that the intra-uterine application of radium has an effect on menstruation proportionate to the dose, 50 mg. of the element applied for twelve hours being sufficient to stop menstruation for several months, and in some instances to establish the menopause permanently. The generally accepted theory is that this result is brought about by a destructive action of radium on the follicles most advanced in development, menstruation returning after the young follicles, on which radium is supposed to have had no effect, have had time to mature. Little account seems to have been taken of the effect which must be produced on the endometrium, on which its greatest power must be exerted.

Considering the small amount of radium used in these cases and the distance from the uterine cavity to the ovaries, to one who is accustomed to the use of radium there must be some doubt arising as to the results being brought about in the manner claimed. It is also difficult to imagine a satisfactory reason why the mature follicles should be killed and the less mature ones remain uninfluenced, especially as everywhere else in biology, the less mature a thing is the greater its susceptibility to disintegrating influences.

In determining changes which may have resulted from treatment, great difficulty is encountered because the normal ovary presents no fixed standard for comparison. In normal ovaries, degeneration is present to a greater or less degree in follicles in all stages of development, comparatively few completing the cycle of growth to maturity and rupture with the discharge of a living ovum. This is particularly true in the rabbit, because ovulation does not take place without copulation. Follicles maturing except at this time do not continue to live, but die and degenerate, and, as pointed out by Graves, all those follicles arriving at maturity during pregnancy must become atretic. It was therefore necessary to examine a large number of normal ovaries to familiarize oneself with the great variations that may exist.

Ovaries of rabbits differ from the human ovaries in the amount of epithelial tissue present. While the human ovary may be described as a connective tissue organ containing graafian follicles and having a fibrous capsule outside of which is the germinal epithelium, the rabbit ovary is a mass of epithelial cells having a thin connective tissue cortex surrounded by the capsule and germinal epithelium. Most of the folli-

cles are found embedded in the connective tissue cortex. The epithelium of the body of the ovary can easily be distinguished from the epithelium of the corpus luteum by the latter cells being of larger size and surrounded by the theca.

The ovaries of rabbits occupy a rather fixed position in either flank, close to the abdominal wall and just above the crest of the ileum. In this position they are much closer to radium placed on the skin surface than are the ovaries of the human being to radium placed in the uterine cavity. Having less tissue intervening, they are therefore more susceptible to the action of the rays.

Fifteen female rabbits were treated, each being given a dosage of 600 milligram hours, the radium applied to the skin surface overlying the ovaries. One was killed in three weeks, two in four weeks, two in five weeks, four in six weeks, three in eight weeks, and four in nine weeks. The ovaries removed were not touched with fingers or forceps. They were placed in 70% alcohol at once and run up for paraffin sections as soon as possible. The first few were sectioned serially and examined throughout. This consumed much more time than was available, and was found to be unnecessary. Therefore in the others, from fifty to seventy-five sections were removed from each side and from the middle portion of the ovary and examined, making about 150 to 200 sections from each ovary. In the examination of sections, special attention was given to the germinal epithelium, the connective tissue cortex, the blood vessels and the follicles.

Macroscopically, the ovaries varied greatly in size. One, a sclerotic ovary, was a mere strip of tissue composed, as seen under the microscope, of only connective tissue with almost no follicles. The author does not think this was the result of the treatment because the ovary was removed only three weeks after treatment, and there were no signs of follicles in a state of degeneration and almost no small follicles of any size, a change so great that it could hardly have taken place in three weeks. The variation in size seemed to depend on the number and size of the atretic follicles and corpora lutea present. Both in number and size these structures varied greatly in different ovaries. In all ovaries examined, the germinal epithelium was present, and in normal condition. The connective tissue cortex varied much in thickness in different ovaries, even the two ovaries from the same animal presenting considerable variation. The blood vessels showed no signs of endarteritis, and as they normally have unusually thick walls, this change could easily have been observed had it been present.

As would naturally be expected, the greatest variation was shown in the condition of the follicles. In seven of the ovaries examined there were no follicles approaching maturity either alive or in a state of degeneration. In twelve there were living follicles at or close to maturity which showed no evidence of having been affected by the treatment. In the remaining eleven all the large follicles were in a state of degeneration. Deducting, therefore, the seven ovaries not containing follicles of sufficient size to be supposedly affected by radium, there remain twenty-three, twelve of which contained large follicles showing no effect from treatment.

In addition to this evidence, two rabbits were put with a male

and became impregnated five weeks after treatment, in one four and in the other five embryos being removed from the uterus several weeks later — rather convincing evidence of the viability of the ovum when it was discharged from the ovary.

Two other animals which had become pregnant were later treated and did not miscarry, indicating that the membrana granulosa of the mature follicles, from which the corpus luteum cells are probably formed, was not degenerated; for it is well known that if the corpus luteum of pregnancy is destroyed in its early stages, the fetus will be cast off.

From these results the author thinks it a fair deduction that a 600 mg. hour dosage of radium does not produce degeneration of the follicles of the ovaries.

Radium in Experimental Cancer.

F. C. Wood, Proc. Pan. Am. Scient. Cong., 10: 500, 1917.

It is extremely difficult to apply the necessary scientific criteria to the investigation of human tumors, as far as radium therapeutics is concerned. It is not always possible to obtain satisfactory specimens for microscopic examination, especially if the tumor is in the internal organs, the danger of over-treatment with resulting severe burns is always imminent, and in this country, at least, we are unable to obtain any satisfactory proportion of autopsies on persons dying from any cause after treatment. The result of this is that the medical literature is filled with a lot of practically worthless reports of the effect of radium on tumors.

The author is of the opinion that the percentage of cures of cancer is extremely small and confined mostly to certain groups of tumors, among them the basal-cell tumors of the face, the epulides of the jaw, the giant-cell sarcomata of the long bones, the adeno-carcinomata of the uterine body, and certain lymphosarcomata. All of these tumors may undergo a spontaneous disappearance, at least for such periods as would warrant the diagnosis of a clinical cure, or are curable in some instances by the mere removal of the main mass; although later there may be a fatal recurrence. For these and other reasons it is necessary to turn to spontaneous or implanted tumors in animals as a means of scientifically testing the therapeutic value of radium.

First, it is important to know what the minimal lethal dose of radium is for cancer cells outside of the animal; the viability of the treated cells being tested by inoculation after treatment. Such experiments have shown that when the alpha rays are removed by suitable filters, 100 milligrams of radium element at a distance of approximately 5 millimeters require one hour to kill carcinoma or sarcoma cells of the mouse or rat in vitro. If the filter used is of sufficient thickness to remove all of the beta rays also, the time required is increased seven or eight fold. The experiments have shown that in order to produce these effects no other factors are in play except the amount of radium, the length of the exposure, and the distance between the radium and the tumor cells. This furnishes a lethal coefficient which can be plotted as a simple rectangular curve and by means of this anyone can deter-

mine the exact length of time required to kill a cancer cell at a given distance with a given amount of radium.

Second, it is necessary to find the lethal dose of radium for cancer cells when these are left in the tissues with their full blood supply, and experiments carried out to determine this have shown that the amount of exposure required to produce the same results is considerably greater, in fact nearly double the amount required *in vitro*. Evidently there is some interference with the destructive action of the rays caused by the renewal of the cell substance through the circulation.

Third, it is important to find the lethal coefficient for human cancer. So far as clinical experience goes, the lethal death point of human and animal tumor cells is very nearly the same. As it is impossible to inoculate human cancer cells after treatment, it has been necessary to grow them in culture, a complicated and difficult procedure. Another factor in the treatment of human material is that it is probably not necessary, in order to produce a cure, to kill all of the cells; but that if a certain amount of radiation is given, the closure of the blood vessels by the endarteritis which the radium produces and the new growth of connective tissue induced as a repair process following the arterial thrombosis and as a direct effect of the irritating action of the radium on normal tissues, may effect a choking of a certain amount of the carcinoma, and produce a temporary or symptomatic improvement of considerable extent. This may explain the fact that in some cases less exposure is needed to cure a small human cancer of low virulence than to kill a mouse cancer *in vitro*.

Experiments in treating primary tumors of animals and the results of treatment of human cancers of high malignancy have, however, shown that in those portions of the growth where the cells of the tumor are in contact with normal structures it is extremely difficult to destroy the healthy blood vessels, and, therefore, to influence the shell of carcinoma tissue, which still remains, even though the main mass may have disappeared under the influence of the radium. It is from this shell of actively growing neoplasm, thin as it may be, that recurrence takes place and this is the difficult phase for any permanent cure.

To a certain extent we are able to judge the type of tumor which may be influenced with radium; that is, any tumor rich in giant cells, especially of the myeloplax type. But, until we know just exactly what radium will do, it is improper to apply it to operable tumors, and we ought, therefore, in our experiments on human beings, still to use only such tumors as are decided to be absolutely inoperable.

SECTION XII
RADIUM—APPARATUS

United States Radium Corporation
New York

SECTION XII

RADIUM—APPARATUS

Instrumental Difficulties and the Error of the Square of the Distance in Curietherapy.

D'Halluin, J. de radiol. et d'électrol., 5: 502, Paris, Nov., 1921.

It has been customary to express values in terms of radium bromid, instead of metallic radium. Until recently tubes containing the bromid were deficient, in that they were not always exactly filled, and the salt was therefore freely movable and unevenly distributed. To test this a silhouette of the tube can be taken on a plate. The law of the square of the distance holds true only for punctiform sources of emanations, but not when a series of tubes are used together, for in that case the point irradiated receives both direct and oblique rays. Oblique rays are less active according to their length. As curietherapy is commonly used, therefore, the intensity appears to be inversely proportional to the distance (not to the square of the distance), although the formula is complex and depends upon numerous factors.

Lead Block for Holding Radium Needles.

C. F. Bowen, J. A. M. A., 76: 1397, 1921.

Physicians using radium needles appreciate the difficulties in threading them. The trouble has been to hold the needles properly while they are being threaded. It is not a question of the mechanical difficulty of holding them so much as it is of protecting one's fingers while the needles are being threaded.

The author presents a device which has been of the greatest mechanical help and at the same time offers protection from the rays given off by the radium. It consists of a block of lead about two inches wide and four inches long into which have been made ten holes for holding 100 mg. of radium, distributed in ten needles.

The holes are of sufficient depth so that when the needles are placed in them just the eyes project above the surface of the lead block. The row of holes is placed along the one side so as to give greater thickness of lead between the needles and the operator. If the end of the thread is properly prepared, it can be held in a pair of long forceps and the needles threaded without difficulty. The surface of the block of lead can be used to steady the forceps holding the thread.

After the needles are properly threaded they can be removed from the lead block and sterilized before being inserted. It is even possible to place the entire block of lead, containing the threaded needles, in a receptacle containing the sterilizing fluid; but in this case the holes in the lead ought to be of sufficient size so that the antiseptic can readily enter and surround the needles. Such an apparatus completely protects the operator and makes the threading of the needles much easier.

An Inexpensive Radium Capsule Holder.

G. E. Pfahler, Am. J. Roentgenol., 8: 30, 1921.

There is much risk in handling the capsules containing radium element, and in the process of screwing these capsules together or separating them there is unnecessary exposure of the fingers to danger. Any device that will help to keep the fingers at a distance will be useful and will lessen damaging effects. Several capsule holders have already been designed, but each one will fit only the capsule for which it has been made. The author therefore searched in instrument stores and elsewhere, but finally went to a hardware store, where he found a chuck which is $10\frac{1}{2}$ cm. in length and which can be adjusted to take any of the capsules varying from 4 to 6.3 millimeters. The cost of this chuck is 85 cents, plus the labor of drilling the soft jaws. It is necessary to drill out the chuck in its central portion so that when it is wide open it will just grasp the largest sized capsule.

In the author's experience this chuck is superior to the instruments made costing \$12 to \$15. It can be lengthened as much as desired by setting the handle into a wooden handle. (Fig. 1 shows a Goodell Pratt Co. Second Size Drill Chuck). The remainder of the metal, if desired, may be covered with rubber.

There are three plates, Fig. 1, as mentioned above, Fig. 2 showing a Starret Pin Vise grasping one of the radium capsules, and Fig. 3 showing the same pin vise with cap removed, showing the jaws which have been drilled out sufficiently to take varying sized capsules.

The Effect of Different Filters on Radium Radiations.

E. H. Quimby, Am. J. Roentgenol., 7: 492, 1920.

In deep radium therapy, filters of various metals are used to remove the beta and soft gamma radiation. There is considerable difference of opinion as to what metal is most suitable for this purpose. For instance, some use lead almost exclusively, while others strongly condemn it. In any case, what is of importance is the quality of the radiation reaching the tissue. After carrying on a group of experiments, the author comes to the following conclusions:

Equivalent filters of different metals have been determined which give the same intensity of ionization in the apparatus described in the article.

When the radiation filtered through these "equivalent" thicknesses is transmitted through tissue, the ionization produced is not the same.

For thin filters, up to half a millimeter of brass or its equivalent, the radiation transmitted by lead is more penetrating than that transmitted by brass, which in turn is more penetrating than that from aluminum. When the absorption by the tissue becomes great in comparison to that by the filter, this effect is obscured.

For thick filters, equivalent to one millimeter of brass or more, this effect is reversed, the radiation transmitted by lead having a larger percentage of soft radiation than that transmitted by brass or aluminum.

To obtain the necessary penetrating radiation for deep therapy, in general a combination of filters is necessary. When substances of high

atomic weight are used as filters, a considerable part of the emergent radiation is easily absorbed in tissue. Hence the necessity of a secondary filter of low atomic weight to remove this soft radiation. The analysis by tissue of the transmitted radiation enables us to determine what additional filtration is necessary when any metal is used as the primary filter.

For practical reasons brass is a good substance to use as a primary filter. Its secondary radiation is not very intense and can be removed to a sufficient extent by a few millimeters of rubber, which have the same effect as an equal thickness of tissue. A thickness of 2 millimeters of brass is sufficient for deep therapy.

The results obtained in the author's experiments are directly applicable to the treatment of patients, since the results by the tissue used is the same, within the limits of experimental error, as that by living tissue.

Apparatus for Implantation of Radium Emanation Points.

R. M. Lewis, Surg. Gynec. and Obst., 30: 528, 1920.

In treating certain types of malignant tumors with radium, the implantation of minute capillary glass containers filled with emanation is more efficient than in any form of surface emanation. The emanation or active gas is given off from the radium, and transferred by a mercury pump into a fine capillary glass tube about 3 to 4 mm. long, which is then sealed.

For growths of the bladder the author devised an instrument which would work through a cystoscope. A stylet is attached to the trigger to push the end of the stylet out flush with the end of the needle, thus forcing out and embedding the emanation in the tissue. Before using the instrument alcohol sterilization is sufficient. The tiny emanation containers are laid in the hollow needle in front of the plunger. A little sterile vaseline on the needle point prevents the contained point from slipping out accidentally.

An Instrument for the Application of Radium to the Bladder.

William H. Woolston, Surg. Gynec. Obst., Dec., 1920.

For the application of radium to tumors of the bladder wall Woolston uses a capsule of platinum, silver, or gold, preferably the first, on one end of which there is a clip attachment. This clip is made of a watch spring, and the points are sharp so that they grasp the tissues firmly. The arms form a figure eight, and are firmly embedded in the end of the capsule. At the other end there is an eyelet for the attachment of a strong silk cord or fine wire. The forceps used has a hollow cylindrical shaft about fourteen inches long with a hollow obturator or plunger. When the capsule is drawn into the forceps the closed end of the figure eight is compressed, opening the jaws of the clip. By means of the obturator or plunger the capsule is expressed, and the spring clip is released, the points grasping the tissues as it closes. When the clip is firmly attached and the instrument removed, the guide of silk or wire running from the capsule through the urethra to the outside is fastened to the thigh with adhesive plaster until the

radium is taken out. To remove the capsule the guide is threaded through the obturator and the capsule engaged into the end of the instrument. When the obturator is withdrawn and traction put on the guide the capsule is drawn into the forceps, the clip is compressed so that the jaws open, and the tissues are released. The bladder should be kept distended with five or six ounces of sterile water during the application in order to prevent the walls from falling together, in which case a burn might result on the normal mucosa. The instrument can be used only through a direct operating cystoscope.

Glazed Flat Radium Applicators.

Ch. H. Viol. Radium, 9: 13, 1917-18.

As the flat varnish applicators are not very durable, the author has devised a glazed flat applicator which lasts longer. These applicators are prepared using a lead-free glass, such as has been used for years in the preparation of tubes of radium salt. Being lead-free, the density of the glaze is low, and the absorption of the softer rays is not much greater than in the varnish applicators. This absorption of beta rays is reduced to a minimum by the use of as little glaze as possible, since it was found that some of the first glazed applicators prepared were not altogether satisfactory because of the absorption of too great a proportion of beta rays. Owing to the high melting point of this glass silver has been selected as the best metal for the backs, and the applicators are supplied without the usual handle, in the form of flat, square or circular discs, containing the radium salt uniformly spread over the glazed area, the glaze being fused in a slight depression in the metal disc. Slight cracking in the glaze sometimes results but experience has shown that this is not serious, plaques in this condition having been suspended in boiling water, and then dropped into ice water, repeatedly, without loss of radium; and even rough mechanical treatment such as repeated dropping the plaque from a height of three or four feet to a hard floor has not caused the glaze to chip out.

The limitations as regards amount of radium salt per unit area is not as great for the glazed apparatus as for the varnish. Thus far there have been prepared a number of plaques containing 25 mgm. of radium element in an area of two square centimeters, which on the London Radium Institute basis is two and one-third times full strength. These applicators have been found quite satisfactory in service, and are of a "strength" that would be very difficult to prepare using varnish; and if prepared with varnish would have a brief life of usefulness before requiring remaking. The life of the glazed applicators should be much longer than that of the varnish applicators of corresponding strength, as the glass does not deteriorate the way the varnish does, and the greater mechanical strength of the glazed applicators should make them withstand rough handling much better than the varnish applicators.

Descriptions of Two Radium Applicators for Malignant Disease of the Mouth and Pharynx.

C. H. Bubb, Arch. Radiol. and Elec., 21: 293, 1917.

The first applicator was for a case of endothelioma of the soft palate. It consists of a vulcanite plate with an extension carried backwards corresponding to the area of the growth, but not in contact with its surface, a space of 3/16 inch intervening. On the palatal or upper surface of this vulcanite extension are fashioned a series of antero-posterior and lateral grooves. The grooves are lined with lead and serve to accommodate one or more tubes of radium. The tubes are prevented from slipping by two metal flanges, working on a swivel at one end and notched at the other end to allow the flange, in the closed position, to embrace a screw inserted into the vulcanite. This screw can be tightened when necessary. By this means the radium tubes are securely retained in a known position. The lead lining of the grooves effectually screens surrounding tissues and allows the action of the emanations to be localized to any desired area of the growth.

The second applicator was for a recurrent epithelioma of the pharynx. In this case a skeletal appliance was adopted as the patient had a solitary canine tooth standing in the upper jaw. The apparatus consists of a shell crown, divided on its buccal surface, to which is attached a screw and threaded bolt so that a firm grip can always be maintained on the tooth. From this gold crown an oval wire extends backwards to give attachment to a vulcanite block, corresponding roughly in size to the area of the growth. This block is lined with lead on its palatal and pharyngeal surfaces and permits the insertion of a lozenge-shaped radium tube as well as a circular one. The method of fixation is similar to that described in the preceding case.

Treatment of Sclerotic Middle Ear Diseases with Radium. The First Successful Application of the Method: New Apparatus.

Z. von Dworzak, N. Y. M. J., 106: 598, 1917.

In the treatment of otosclerosis and other middle ear disease, the author uses radium rays as well as the radium emanation. He believes that the use of the radium emanation is original with him. He applies it directly in the tympanic cavity, as the tympanum, like all other fibrous membranes, offers much resistance to the rays.

The amount of radium varies from one to ten mgm. radium element. The radium tubes are applied by means of the radium applicator and are centered in the ear by means of a head-band to which is attached a small ear speculum, by means of which it is possible to introduce and remove the applicator and watch the reaction. A brass filter eliminates the alpha and beta rays and the therapeutically active gamma rays penetrate the tympanum and middle ear. A larger amount of radium is also used to ray the entire ear region.

The author manufactures the radium emanation in an emanator of special construction. Oxygen bubbles out of a tank through the liquid in a bottle which contains the radium in solution. The quantity of this oxygen is regulated to a nicety by means of two manometers and a gas meter. The oxygen in passing takes up the radium emanation

and can be used for inhalation, by means of a mask or in a room, for the activation of water for drinking purposes or for the treatment of the ear directly in blowing it through the Eustachian tube in the middle ear. In the latter case he uses either the pressure of the oxygen alone, or combines the emanator with the Meyer-Rowan instrument which the author has adapted for that purpose, so that sound waves or air under pressure will force the emanation into the tympanic cavity, depending on the character of the disease being treated. At times he has had the patient inhale radium emanation and let him inflate the Eustachian tube by Valsalva's test.

In all cases it is necessary to remove the excess radium emanation after the treatment by means of suction from the external auditory meatus or by pressure through the Eustachian tube or both combined; for radium emanation remaining in the middle ear could ultimately cause damaging after-effects. Radium D, one of its products of decomposition, lasts sixteen years and might remain active too long in the middle ear.

A Direct Reading Emanation Meter (Ionometer).

H. Greinacher, Ztschr. f. Balneol. Klimat., etc., 8: 56, 1915-16.

A machine is constructed which measures directly the amount of radium rays present in the air, indicating this by means of the ionization effect of radium rays. The apparatus consists of three parts. (1) A small box containing two metal plates; (2) an electroscope with two leaves; (3) an upright rod. All except the rod are enclosed in a wooden case.

The way in which the meter works is as follows: The lower plate is charged by means of a current. Since both plates are covered with a radio-active substance, the air between them is a conductor. The upper plate is thus charged, and simultaneously, the electroscope and the projecting rod (Z). The leaves of the electroscope spring apart, and rest at the zero point on the scale. If the air around Z is ionized, electricity flows out from Z into the surrounding air. A corresponding current, however, is flowing in from the air between the two plates. The electroscope is discharged, the leaves draw nearer to each other. The distance through which the leaves move while approaching each other is governed by the amount of electricity, i. e. emanation in the air. Each movement of the leaves corresponds to a definite amount of emanation present in the air. Hence the scale measuring the distance through which the leaves move is so divided that each scale division represents a certain amount of emanation per liter of air.

For the initial charging of the instrument contact can be made with the electric lighting system. A voltage of 220 is essential, however, so that if the existing voltage is only 110, an auxiliary battery of 110 volts must be employed. If desired, instead of connecting with the lighting system, a battery of 220 volts may be used. For other voltages the author has constructed another instrument.

New Conceptions Relative to the Treatment of Malignant Disease with Special Reference to Radium in Needles.

W. L. Clark, Penn. M. J., 24:214, Jan., 1921.

The lethal action of radium, and in a lesser degree of the x-rays, upon malignant cells of all types—some types resisting more than others—has been proved both in the laboratory and in practice.

It is recommended, after observing the good results in practice, that at least one maximum radium treatment with proper technic be given preparatory to any surgical procedure for the purpose of first inhibiting and finally rendering benign the migratory cells in the ducts, and producing glandular fibrosis. It has been the author's custom to allow a week or more to elapse between the radium treatment and whatever operative work is undertaken; but if the lesion is growing too fast, this may be modified. At least three cross-fire radium treatments, averaging six weeks apart, should also follow operation.

If the invaded glands have not broken down, they will usually disappear under judicious cross-fire radium treatment. If the glands are small, treatment may be given externally; if large, radium needles should be inserted directly into the glands.

The adaptation of hollow, metallic needles, each containing some radium salt—preferably the sulphate—representing a known quantity of radium element, has revolutionized radium technic. The author uses needles containing 5 to 10 milligrams. These needles are used for insertion into malignant growths and glands, or into an organ contained in the peritoneal cavity after exposure of the lesion by laparotomy. The method of application by needles is more accurate and produces more favorable results than application from the outside or insertion of a capsule through an incision. But there are times when only the two latter can be used.

As many needles as necessary may be inserted 20 to 25 mm. apart, to any depth into the tissues, thus taking advantage of concentric cross-fire radiation from needle to needle. If a sufficient number of needles are available, they may be grouped together and put into a capsule of brass or other metallic filter and covered with rubber. These may be used in the same manner as the ordinary radium capsule, or the needles may be placed side by side in a suitable flat metallic container covered with rubber and used whenever a flat plaque of standard construction is indicated for the treatment of malignant disease. After various experimentations an alloy of steel and nickel known as "non-corrosive steel" was adopted for the needle. These needles have been made to order in lengths varying from 20 to 30 mm. Some are round with tapering point, others having cutting, trocar points, some are flat but maintain their hollow center. The eye of the needle is tapering so that it may be withdrawn easily by means of a braided silk thread after insertion below the surface. The shorter needles are used in the more delicate structures, the long ones in those less delicate and more extensively diseased. The wall thickness is invariably 0.5 mm. The diameter at the widest point is 2 mm. The hollow needles are divided about 1 mm. below the eye.

It is still the opinion of some physicists and radiologists that radium needles are of little practical utility, since it is thought that

the secondary radiations from the metal in contact with the tissues cause great irritation and objectionable sloughs even with short exposures. Clinical experience has shown the fallacy of this idea, if exposure is not too long. Besides, the radium needles are inserted into moist tissues, and the film of moisture surrounding the needles may be sufficient to absorb the secondary rays and destructive beta rays. These needles may sometimes remain in the growth for 24 hours, causing its retrogression and even disappearance, but no destruction by sloughing.

Radium needle treatment should be administered in a hospital under strictly sterile conditions with a trained nurse in attendance. No rule can be given as to individual treatment, as each case is different, but as a general rule, the needles placed in sarcomatous tissue 20 mm. apart should be withdrawn in 12 hours. In carcinoma needles placed 25 mm. apart should be withdrawn in 18 to 24 hours.

SECTION XIII

RADIUM

- A. Dangers of
- B. Injurious Effects

SECTION XIII

RADIUM

A. Dangers of

B. Injurious Effects

The Dangers of Penetrating Radiations and Means of Avoiding Them.

André Broca, J. de radiol. et d'électrol., 5: 414, Paris, Sept., 1921.

Radium emanation consists of positively charged particles, which after they have lost their charge, form helium. As this gas is inert, its so called toxicity can be due only to the penetrating rays which are bound up with it, and which can reach considerable importance only in an atmosphere charged with the emanation, which, being gaseous, rapidly diffuses. It is probable that almost always, especially near mineral deposits, there is a certain harmless amount of emanation in the air that we breathe. When the cause of the danger is thus known, precautions can be taken: proper screening and ventilation are sufficient protection to the personnel of institutions, whose health should be further guarded by frequent blood counts and vacations. Persons living in the neighborhood have nothing to fear.

Attendants should be careful never to touch the emanation tubes except with forceps, and to keep at a safe distance. The current generated can be measured in milliamperes by a gold-leaf electroscope screened with metal. Attendants of persons who have just been treated should not remain constantly nearer than 3 meters to the bed. The danger is of the same degree of probability as that daily run by physicians and nurses in the care of contagious diseases, and is really inconsiderable if it is clearly understood and proper precautions are taken.

Precautions for Radium Workers Against the Rays.

A. Félix, J. radiol. et d'électrol., 5: 61, Paris, Feb. 1921.

There are two means generally employed for protection against radium rays, first distance, which is very efficacious, and second, the interposition of absorbing screens. Régaud and Ferroux have devised a number of simple sorts of apparatus which give a maximum of convenience and security to the worker. There are continuous pressure pincers for holding the tubes, as well as pincers of another form for the manipulation of the filter cases. There are also pincers for the manipulation of the platinum needles. Cylindrical nickled copper cases for carrying the bare tubes should be used, and these cases may be carried by the dozen in nickled copper boxes lined with lead 3 mm. thick. These boxes in their turn are placed in a leather sack or in a wooden box fitted with a long strap which will keep the active tubes at least 25 cm. away from the hand in carrying them. To guard against the danger of removing the tubes and arranging them for use, a table has been devised for a single operator composed of two thicknesses of wood, 2 cm. each, with two sheets of lead, 1 cm. each, between the two pieces of wood. In the middle of one side of the table, where the operator is to sit, is a rectangular shield, also composed of 2 cm. of lead between two thicknesses of wood. This shield is 40 cm. wide and 25 cm. high

The shield is placed vertically to the edge of the table and the operator sits so that the shield protects his breast, his arms passing in front of it on either side so that he may manipulate the active apparatus on the table. Thanks to this arrangement, the torso and lower limbs of the worker are protected by the 2 cm. of lead from all the beta radiation and from 90% to 100% of the gamma radiation. Only the forearms and the head are left unprotected. The table is very solidly constructed of oak. The lead is covered first for reasons of cleanliness and second, the intense secondary radiation produced by the lead might finally seriously injure the skin of the arms. The worker should always keep in mind the importance of the factor of distance, which is equally necessary, whether the rays are well or slightly filtered.

Danger of Radium. Use of Protective Methods.

Bordier, Bull. de l'Academie de Méd. Paris, Mar. 1921.

It seems that radium submits those who handle it to graver dangers than the x-ray. The knowledge of this danger is the more urgent, inasmuch as no warning is given as is the case with the x-ray, by skin lesions, particularly those of the hands. It is on the hematopoietic organs that the radium rays act, and this in a surreptitious manner, to the ignorance of the subject who does not feel any pain and finally ends in grave trouble, even fatal pernicious anemia, as in the three cases of a nurse, an attendant, and a laboratory boy. In these three cases the number of red corpuscles had fallen respectively to 1,100,000, 800,000 and 527,000 per cubic millimeter. Anemia in the three cases was typically alike, existence of polynuclear leukopenia and complete absence of regeneration signs. This anemia had all the characteristics produced by toxic gases, like nitrotoluol.

The conclusions of the dangers of those who are exposed to radium rays are based on laboratory experiments and the blood examination of several attendants of both sexes in the Radium Institute.

Several rats were exposed to radium rays for different periods, the femur marrow was then treated with eosin and methylene blue. It was observed that the number of mitoses diminished neatly and fell from 80 normal to 40, according to the duration of the irradiation. In regard to the attendants, the examination of the blood furnished the following: the majority present a notable diminishing in number of red blood corpuscles comparative with blood of subjects living in same building but not exposed to radium. These experiments show that the very penetrative radium can have destructive action on the marrow of the bones and the other hematopoietic organs. It is well to call the attention of the radiologists to the danger of new x-ray bulbs; the penetrative strength of these rays is daily becoming stronger and more akin to that of radium rays, thereby submitting radiologists to dangers of the same order as observed in the foregoing cases.

Radium Burn of the Vagina Resulting in an Ileo-Vaginal Fistula.

T. W. Harvey, J. M. Soc. New Jersey, 17: 418, 1920.

Mrs. D. aged 68. Twenty years ago had had a vaginal hysterectomy.

tomy, and has had no local symptoms since then. In 1920 she began to have a bloody vaginal discharge. Examination showed a small ulcer on the hysterectomy scar in the vagina. As this did not yield to treatment, Mrs. D. was sent to the Memorial Hospital. A section of the ulcer showed that it was epithelioma and the application of radium was advised. The reaction of the radium treatment was quite severe, but the local symptoms disappeared with the exception of a slight vaginal discharge.

About six weeks after the radium treatment, a fecal discharge began to come from the vagina. This was very irritating and very painful. Examination showed that there was a normal middle scar with a small perforation from which there exuded a discharge of the contents of the small intestine. Operation set the patient right once more, and she now has no local evidence of the disease, only the radium scar.

The accident of a fortuitous adhesion of the intestine to one side of a scar, which became the seat of an epithelioma on the other side; the burning by radium which penetraed the intestine and caused the fistula; the disappearance of all signs of malignancy after the application of the radium, these are the unusual features of this case.

Injuries Due to Radium. Reports of Typical Cases and Recommendations for Prevention.

T. Ordway, Scient. Am. Suppl., 81: 254, 1916.

The author reports in detail nine cases of injury to the fingers due to the handling of radium and radio-active substances. The local objective changes consist chiefly of flattening of the characteristic ridges, thickening and scaling of the superficial layers of the skin and even atrophy and intractable ulceration. These lesions are usually slight compared with the marked subjective symptoms, such as paresthesia, anesthesia of varying degree, tenderness, throbbing and even pain.

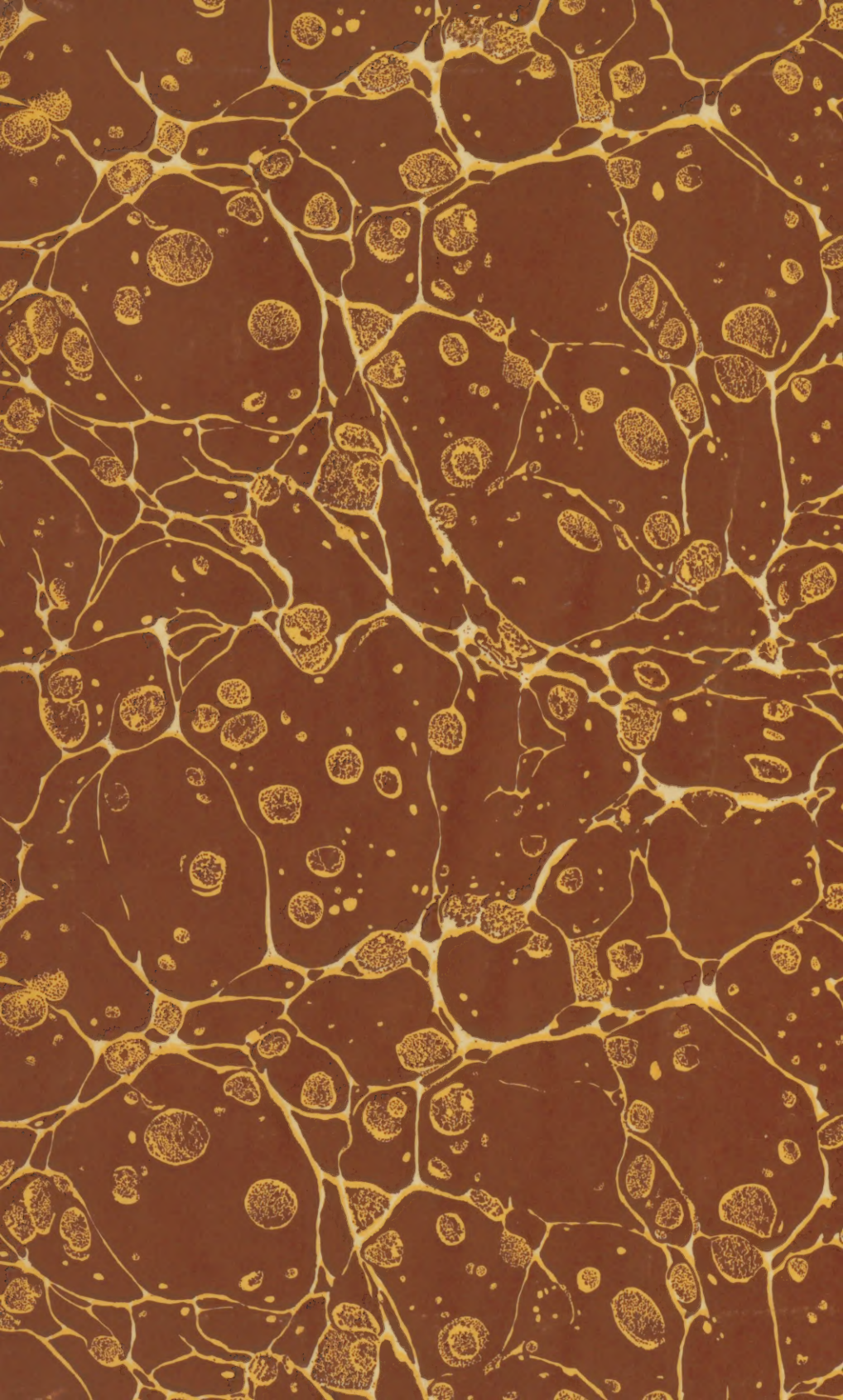
Various methods have been devised for avoiding these injurious local effects, by the least possible contact of the fingers with the radium. Forceps or special vises are used for holding tubes and screwing in or out the tips and eyes; special applicators in the form of metal boxes have been constructed so that the active tubes may be added after the filtration and protection have been arranged, and the surface applicator is then slipped by forceps into a special rubber envelope and fastened with adhesive. This is particularly to avoid wrapping them up by hand in sheet rubber. Leaded gloves, fingers, etc. are clumsy and are not readily worn.

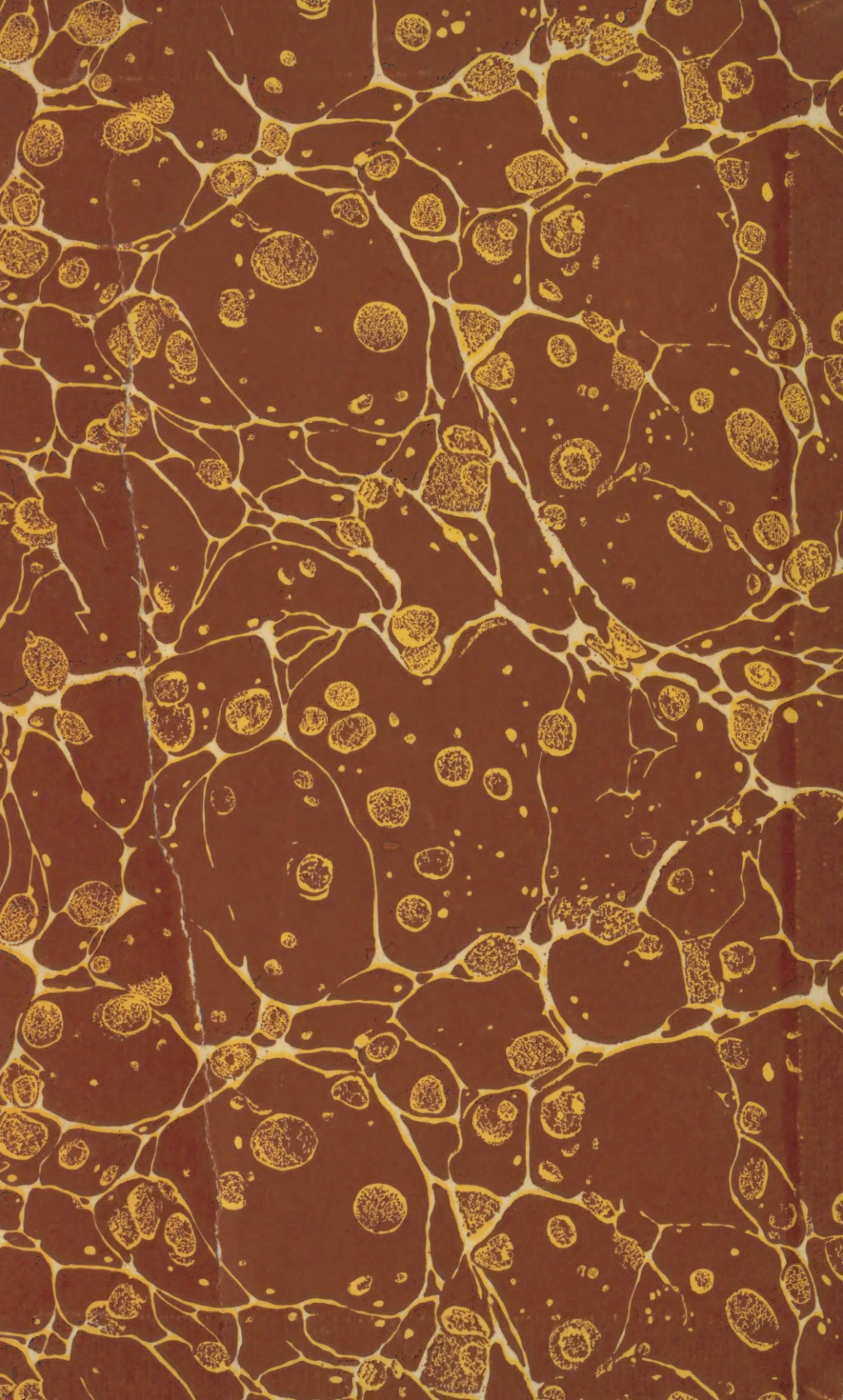
In placing active tubes in special applicators, it will probably not be possible to avoid all contact with radium, and as the effects are not apparent at once, as when handling very hot objects, it will be difficult to train a worker to avoid contact with the active apparatus.

In the work of making routine application of radium there should be a routine in the staff, and persons affected should be freed, at least temporarily, from such work.

Various general systemic symptoms and also blood changes may be produced by exposure to radio-active substances. In order to avoid possible general disturbance, the body should be protected as far as

possible by metal screens in form of boxes or plates about the radium; there should be frequent ventilation of work-rooms, particularly if radium emanation is present, and a change of duty, shorter hours and periodic physical examination of those working with radio-active substances.





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